What Kind of Information Do Drivers Need? An Investigation of Drivers Information Requirements in Kuala Lumpur, Malaysia

By

Ismail B. Maakip

A Doctoral Thesis

Submitted in partial fulfilment of the requirements

for the award of

Doctor of Philosophy

of Loughborough University

December, 2000

Certificate of Originality

This is to certify that I am responsible for the work submitted in this thesis, that the original work is my own except as specified in acknowledgements or in footnotes, and that neither the thesis nor the original work contained therein has been submitted to this or any other institution for a higher degree.

.... (Signed)

.... (Date)

Abstract

Past research indicated that driver information requirements were varied (e.g. Spyridakis et al., 1991) and the motorists population cannot be consider homogeneous in terms of information requirements (e.g. Haselkorn et al., 1991). Some of the previous studies even suggested that before the so-called intelligent systems go into production, several unresolved issues concerning what kind of information drivers require need to be resolved. Thus, this thesis is interested in exploring several human factors issues concerning drivers;' information requirements. First, the study is trying to provide at least a general picture of what kind of information is suitable to be presented to drivers in certain types of journey. Secondly, the thesis is interested in exploring the suitable timing and mode to present the required information to the target audiences. Besides the aforementioned human factors issues, this research also investigated how drivers plan their routes and find their way in unfamiliar destinations. The study is also interested in examining criteria used by drivers in choosing a route to their intended destination. Finally, this thesis aims to measure respondents' behavioral responses when they were given several traffic messages on congestion while commuting to and from work.

Three studies were conducted. Study 1 (Preliminary studies) explored general aspects of motorists and human factors issues such as information requirements. Study 2 (Main survey) consisted of an interview survey with a larger sample of motorists in Kuala Lumpur, Malaysia. Results suggested that drivers' information requirements were varied. In addition, the findings also confirmed previous work that suggested the motorists population cannot be treated as homogeneous having similar information needs. The results from both studies, i.e. Study 1and Study 2 clearly exemplify that different kinds of journey need different kinds of information. In fact, drivers would require information which is related to the nature of the trips or task that they undertake. In addition, some information was always required even though the purpose of the trips was different. There were also differences between gender and age groups of drivers taking part in this study regarding the information that they required.

The results also revealed that local drivers used more than one strategy for route planning and wayfinding in unfamiliar locations. Maps were the main strategy used by most of the respondents who participated in this study. Other strategies used by respondents were asking a passer-by, relying on memory and going without preparation. Apart from that, this study also demonstrated the difficulty in arriving at a general conclusion concerning the appropriate criteria that drivers would use in selecting a route for different trips. Local drivers would use a variety types of criteria in order to choose a route to a particular destination. However, the thesis identifies that drivers mainly employed three types of criteria in selecting a route to a particular destination. These criteria were safety, saving mileage and avoiding congested routes.

The final study (Study 3) was interested in extending the results of both studies 1 and 2 particularly the presentation of congestion messages to its end users, i.e. motorists. An experiment was conducted to investigate drivers' response towards the presentation of traffic messages about congestion. The findings clearly supported previous work that found different types of information are likely to elicit different kind of responses from the drivers. In addition, local drivers also had ideas about the design of future traffic messages on congestion. For example, the need to have a quick solution when faced with the problem, e.g. offer alternate route; the need to have information on travel time if they decided to use the alternate route recommended by the systems; and some of the messages should be given as early as possible to serve as pre-trip advanced warning to drivers. The findings clearly demonstrated the preference for having more information rather than less.

Contributions

I would like to thank several persons who I am indebted for their courage, effort and encouragement in helping me in several tasks such as handling the focus group discussion and experiments and interviewing respondents.

C.Y. Yuen
Shamsul Akmal
S.M. Rama
M. Siti Khatijah
M. Othman
M.S. Johari
I.Mansor
I.Rosli
K.Dahalan
Nehat Qaidasat. F.K.

Acknowledgements

The co-operation of all participants in this research project is greatly appreciated.

I am grateful to my supervisor Professor Margaret Galer-Flyte for her guidance and encouragement during this research project. I also would like to thank Professor Mohamad Haji-Yusuf for advising me to keep up the good work while wandering in the wilderness.

I also would like to thank to all of the Vehicle Safety Research Group, Loughborough University members such as Dr. Terry Lansdown, Dr. Peter Burns, Dr. Simon Fletcher, Dr. Brian Janes for their kindest assistance and providing me with a greatest sources concerning this research.

I am also would like to thank several experts that have provide me some interesting idea regarding the research such as Rob Graham of HUSAT, Professor Barfield, Professor Rothengatter, Dr. Jane Lippin of Federal Highway Administration, Dr.Verwey of TNO Institute of Human Factors. Indeed, I am also grateful to the National University of Malaysia, my sponsor.

Lastly and the most important, I would like to thank my wife, Faezah Zainal Abidin, my dearest, I grateful indebted to you and thanks for your limitless support and finally my daughter Nur Izzati Aida and my son Ahmad Imran you are my loves one. I also would like to thank my family that has patiently advised to do the good deeds.

Table of Contents

Chapter 1

Introduction

Chapter 2

Aims of the study & Overview

Chapter 3

Literature Review

Chapter 4

Preliminary Studies

Chapter 5

Main Interview Survey

Chapter 6

Survey Results

Chapter 7

Survey Discussion

Chapter 8

Presentation of Traffic Messages

Chapter 9

Discussion & Conclusion

List of Tables

List of tables in Chapter 3

List of tables in Chapter 4

List of Tables in Chapter 6

List of Tables in Chapter 8

List of Tables in Chapter 9

List of Figures

List of Figures in Chapter 3

List of Figures in Chapter 9

List of Appendices

Chapter 1: Introduction

1.1. Chapter Summary

This chapter begins with the description of problems faced by motorists worldwide, e.g. congestion, accidents and pollution. However, these problems can be minimised by the introduction of the so-called Intelligent Transportation Systems (ITS). One of the elements in ITS is the drivers' information systems aiming at conveying information to assist the driver in making decision. Nevertheless, there are several human factors concerns that need to be raised before the system goes into use by its end-users. Several issues such as what kind of information does a driver need, how and when the information should be presented need to be investigated and resolved. In addition, this thesis is also interested in investigating several new issues such as wayfinding, route planning and route choice since there are no studies in Malaysia that investigated such aspects.

1.2. General Introduction

Almost everyone owns a motor car. It is one of the necessity items of the modern society. It is also one of the available means of transportation for a variety of purposes. For example, to gets one to the workplace, to do leisure activities and others which involve travelling. For that reason, the popularity of cars has resulted in several fundamental concerns including congestion, road safety and pollution.

- Congestion

It can be defined as the consequence of the interchange between travel demand and capacity supply. Congestion occurs especially when demand for road capacity becomes larger than the supply. In addition, congestion also appears especially when people are travelling to common spots, e.g., city centers or industrial zones, at approximately the same time, and along the same routes. For instance, the America Federal Highway Administration (FHWA) reckoned that delays on urban freeways cost more than USD$9 billion in 1984 and will cost six times as much by the year 2005. In addition, Lindley (1989) estimated that in the U.S., total urban freeway amounted to over two billion hours with vehicle total wasted fuel at 2.2 billion gallons and total users' costs were estimated to be USD$15.9 billion.

- Road safety

Another negative outcome of increasing traffic volume is the occurrence of accidents. Trinca et al., (1988) estimated that half a million people are killed and 15 million are injured each year in road accidents worldwide. In addition, research has shown that the driver is the dominant causal factor in road accidents. For example, Shinar (1978) has estimated that human behaviour is involved in 90% of all road accidents. Thus, an effective solution is required to make real improvement in safety for the road transport user. For example, infra red safety devices and incident detection have been developed in order to minimise this problem.

- Pollution

Müller (1989) has indicated that as traffic volume increases, so does the amount of environmental damage it causes. Problems such as noise and air pollution are already endangering health and life quality. It has also created more and at times violent reactions from the human race.

These negative aspects of the motor car can be alleviated by employing the new technologies of information and telecommunication, e.g. route guidance or global positioning satellite (e.g. Boyce, 1989). Various new technologies are being developed at a great pace which could help motorists, transportation authorities, and fleet operators to make better use of their vehicles and the highway network. Thus, growing concern regarding road transportation problems have led to a number of research, development, and demonstration initiatives associated with the developments of new technologies in vehicles. These initiatives include the U.S. Intelligent Transportation Systems (ITS), European programs such as DRIVE (Dedicated Road Infrastructure for Vehicle safety in Europe) and others.

This new technology is generally referred to as the Intelligent Transport Systems (ITS). The central theme of this ITS is the application of technological solutions rather than basic road building. It also provides the intelligent link between travellers, vehicles and infrastructure. This new technology will move the transportation sector a step forward by providing travellers information and by operating traffic management and control systems. Numerous benefits are predicted for urban and rural areas. In addition, it also could assist various targeted groups such as elderly and disadvantaged drivers. The Federal Highway Administration (FHA) reported some specific findings revealing the benefits of ITS:

- It could reduce up to 40% of the congestion as projected from initial simulation works and estimation for the Smart Corridor project in Los Angeles,

- It could save approximately 11,500 lives and $22 billion in accident costs based on an analysis which took into consideration aspects like safety technology features, projected market penetrations, and estimated effectiveness in reducing various accident types. By 2020, a similar analysis has estimated an annual savings of 33,500 lives and $65 billion in accident costs as advanced vehicle control strategies achieve a large market entrance;

- It also could reduce excess travelling. This waste can be minimised by introducing route guidance to help drivers find the best alternative routes when their usual routes are congested. Research has shown that potential benefits in term of saved route kilometres can economically justify a countrywide development of electronic guiding systems (e.g. Armstrong, 1977).

One important aspect of the ITS is the driver information system. This system is designed to provide travellers with timely and accurate information with the hope that they will use this information to make better-informed travel decisions. For example, the system might provide a driver with information on traffic congestion between home and workplace, thus helping the driver to choose the best route or take the subway instead. In addition, travelling drivers could use an in-vehicle system that provides real-time congestion information to determine if they should change their usual route to work (Wallace & Streff, 1993).

Although, the new technology has the capacity and potential to minimise road transportation problem, it also has potential limitations. The systems were created primarily with the motivation to create application for new technology whilst placing little emphasis on the characteristics and needs of users. Therefore, the failure to do so raises concern on the effectiveness of the systems as it may impede driving instead of assisting it.

Providing information is no doubt, an essential component of many information systems. However, unresolved issues like what kind of information a driver requires in various situations need to be addressed before the ITS proceeds towards the product development path. Several issues on human factor like the driver interface, driver information, behavioural issues and user demographics should be investigated thoroughly before developing the so-called drivers information system. For example, the development of the driver interface needs to consider the analysis, definition and quantification of the human requirements for a safe and friendly interface between the driver and the vehicle.

On the other hand, issues regarding driver information should cover several aspects such as types, amounts, detail and timing of information and their effects on driving performance. In addition, some of the behavioural issues that needs to be examined should include drivers' reactions to various types of instructions (e.g. an instruction generates unquestioning compliance). Furthermore, system developers should also consider issues surrounding user demographics placing emphasis on factors such as performance attributes, preferences and attitudes, cognitive attributes, and special product requirements for various user groups. All these issues should be looked into in the early phases of designing the information system.

Apart from the aforementioned issues, other fundamental issues also need to be investigated. Ng & Barfield (1997) have listed three basic questions which are often asked regarding motorists information systems:

- What kind of information do users want?
- In what format should the information be presented?
- When do travellers need to access the information?

This list of questions is one of the important components that need to be examined before the actual product is developed for the end-users. In reality, there is much uncertainty concerning what kinds of information drivers need. Indeed, issues such as how detailed should the information be displayed to the drivers has not been examined thoroughly. In addition, there are also many uncertainties about the safest and most effective method to present the information. Furthermore, the timing to present the information also has not been investigated completely. These are some of the issues that need to be examined further before developing specific information systems. These questions seem to be simple to answer. However, the scenario could appear even more complex as evidents show that the needs of drivers differs from one to another, for example, a professional driver may need information different from what is required by a novice. Even within the same group of drivers, their information needs may vary from one situation to another, e.g. commuting or making unfamiliar trips (e.g. Wallace & Streff, 1993).

It is also important to point out that driver information requirements are not homogeneous (e.g. Barfield et al., 1989; Spyridakis et al., 1991). Different drivers may vary in requirements for a system. For instance, a dispatcher may require the fastest available route whereas a holiday maker may want to use the scenic roads. In addition, the needs of an individual driver may also vary over time as in when a novice driver becomes an expert. On the other hand, drivers may require little information while travelling on a highway but details are possibly required when entering a city centre or nearing their final destination.

Issues relating to the questions of what, how and when are interconnected to each other. For example, issues relating to how and when to display the information cannot be resolved without the understanding of the information actually required by the users. Past studies show that the majority of drivers require information but were not certain which ones could really help them (e.g. Streff & Wallace, 1993; Tsai, 1991). Thus, different kinds of situations may induce the need for different kinds of information (e.g. Penttinen et al., 1996; Streff & Wallace, 1993). In addition, the focus of the thesis is to study the information needs of drivers; particularly commuters in Malaysia, which might be different, compared to other countries, e.g. United Kingdom or Japan. Thus, the focus of this thesis is to investigate information needs of drivers in Malaysia in several situations.

Apart from investigating local (i.e. Malaysia) drivers' information requirements, this thesis is also interested in examining local travellers' navigational activities. We could say that the main purpose for driving, in most cases, is to safely, conveniently and independently travel from one point to another. Driving sometimes requires drivers to navigate which involves route planning and wayfinding. Route planning is the navigational preparations people make before driving to an unfamiliar route. On the other hand, wayfinding refers to the decision making process that is required to negotiate a route to a destination. Very little is known about this aspect of driving especially in Malaysia. Thus, there is a need to study this issue, which in turn could help to understand Malaysian drivers' navigational needs.

However, this thesis only focuses upon the methods people use to plan their routes and find their way while driving. The potential consequence of this aspect of driving is wide ranging. For example, Rothe et al., (1990) indicates that navigation does have implications on road safety. In addition, Jeffery (1981) and King (1986) found that poor navigation could contribute to wasted time, inefficient fuel use and congestion. Thus, by understanding the methods that drivers employ to navigate would in turn help responsible agencies in developing some sort of system or mechanism to assist drivers. Information gathered from this study would certainly enrich local researchers knowledge concerning navigational issues and route planning.

In addition, one of the main focuses of this thesis is to investigate the criteria that drivers would employ while making a route choice (e.g. selecting a route to a potential destination). Past evidence has shown that providing information to the drivers could minimise the wastage due to poor routing while on the road (e.g. Jeffery, 1981; King, 1986). Therefore, this matter could be prevented, if drivers could be helped to find the lowest cost routes when using part of the road network unfamiliar to them, by using driver information systems.

The study of travellers' route choice behaviour is primarily oriented towards gaining insight into spatial choice behaviour (e.g. Bovy & Stern, 1990). Such questions may be related to the route choice study, e.g. how do people choose routes in a network, what do they know, what do they look for and which road characteristics or criteria play a vital role. Thus, this study intends to investigate drivers' route choice criteria for several journey purposes. This will help various authorities to learn more about local drivers preferences of using one or several routes.

The study could also provide an insight into criteria that drivers take into account when choosing a route for various journey purposes, particularly in Malaysia.

In conclusion, the emphasis of this research is on commuters with the aims to identify and to provide information in understanding drivers information requirements for different journey purposes. Moreover, the study serves as a starting point to other future research regarding motorists as a whole and provides insights into other issues covered in this thesis.

1.3. Chapter Conclusion

Driver information systems provide information that can assist drivers in their driving task. However, the systems have been developed without sufficient consideration of drivers' needs and a complete understanding of the problem. Besides, little is known regarding what information drivers need and various navigational activities, e.g. wayfinding. Thus, there is a need to study several important topics as to what information a driver actually needs and others that are covered in this thesis. In order to develop the system, a study on Malaysian driver's information requirements is important. This thesis which aims at investigating drivers information requirements for various journey purposes and several others could help the Malaysian government and other responsible agencies to consider the possibility of employing new technologies (e.g. motorists information systems) in road transportation.

Chapter 2: Aims of the study & Overview

2.1. Chapter Summary

In this chapter, the aims and objectives of the thesis are described and their rationale is provided. Summary of methods employed in this research is also described. A summary of the thesis structure is also given.

2.2. Introduction

In its strive to become an industrialised nation, the last five years have witnessed a rapid development for Malaysia. The expansion of the economic activities in the urban areas has not only attracted immigrant population but also generated an increase in travel demands. The continuing increase in population and economic activities had resulted in greater mobility. As the need for more public transport was not urgently met, more people became dependent on private transport. The growth of private vehicles depends primarily upon the growth of income and price of car. Besides that, other factors are also significant. They include factors such as changes in shopping habits, amount of frustration due to congestion, and the availability of alternative cheap and convenient forms of transport, e.g., private cars. The increasing use of cars improves mobility of their users but also creates serious problems in cities: deterioration of public transportation, pollution, congestion and road accidents.

The existing road network seemed to have failed in carrying large traffic volumes as the country grapples with rapid population growth and the increased demand for private vehicles. Travelling by private transport was and will continue to be a popular means of movement in Malaysian cities and towns. For example, in Kuala Lumpur, travelling ratio by private transport stood at 4:1 compared to public transport (Ibrahim Wahab, 1985). In addition, he also estimated that total trips of vehicles entering Kuala Lumpur in the year 2000 would be 3.3 million vehicles which would comprise 2.2 million private vehicles and only 1.1 million public transport.

The dilemma facing drivers, especially commuters in Kuala Lumpur and throughout the world is that, while demand for mobility continue to increase, the available capacity of the roadway systems is nearly exhausted. Increasing traffic in the urban areas, especially in Kuala Lumpur resulted in congestion. Techniques employed by the government to reduce congestion typically focused on capital intensive strategies such as the development of new roads or light rail train to increase system capacity.

An alternative strategy is to design an information system based specifically on the information needs of motorists (Dudek & Jones, 1970). As mentioned earlier in Chapter 1, the information systems could assist motorists in many ways, e.g. drivers may receive information from the system about traffic condition and others which could influence their decision. For example, drivers may change route if they were given a message regarding congestion on their regular route.

Thus, in order to develop driver information systems, the design must be based on an understanding of the traffic information needs of travellers. Therefore, this study intends to investigate local driver information requirements in various different situations, e.g., commuting and unfamiliar trips. The findings from this research will benefit not only the drivers but also traffic authorities and the government. The study is also interested in exploring new issues which have not been investigated in Malaysia, e.g. route choices and navigation strategies.

2.3. Research Aims

A risk with the development of driver information systems is that they might not be suitable to all kinds of drivers or the technologies offered by the technology are placed above the needs, abilities and limitations of the driver. Thus, it is better to, first, address several basic questions before the system goes down the development path. The overall and most important aim of this thesis is to investigate and define the traffic information requirements of drivers travelling to and from work in major cities in Malaysia. Specifically, the principal aims of the thesis are as follow:

1. To investigate the information drivers require in different situations, i.e. *Commuting trips*, *Unfamiliar trips*, *When dealing with congestion* (e.g. while commuting to and from work), and *When deciding to divert to an alternative route* (e.g. while commuting to and from work).

2. To determine the appropriate timing to present the information in these situations.

3. To identify the best mode of presenting the information that drivers required in these situations.

4. To identify the criteria drivers prefer when selecting a route in various types of journey This refers to how drivers choose a route, e.g. *What are the criteria that influence them to select a route from home to work, What are the criteria that influence them to choose a route from work to home,* and *What are the criteria that influence them to choose a route for unfamiliar trips.*

5. To gain an overview of the strategies that drivers use when navigating in the unfamiliar environments. This refers to how drivers currently navigate in unfamiliar environments, e.g. what strategy they use when planning the trips (route planning) and finding their way (wayfinding) in various different unfamiliar environments: *What navigational strategies did they used in unfamiliar cities, What navigational strategies did they used in unfamiliar highways,* and *What navigational strategies did they use in unfamiliar routes.*

6. To assess behavioural issues regarding the presentation of audio traffic messages to drivers, e.g. *What are drivers' decisions when given various traffic messages on congestion, What are the important elements or important content of traffic messages which can influence driver's decision,* and *Preferences toward traffic messages which were given to them,* e.g. what do they prefer to be included in future traffic messages on congestion.

2.4. Rationale of Research Aims

The objectives of this thesis are to investigate drivers' information requirements particularly for commuters in Kuala Lumpur, Malaysia. The reason for choosing commuters as the potential subjects is due to the growing number of commuters in Malaysia, who use private vehicles as the means of transport. Thus, this study is interested to investigate several objectives that are related to commuters in order to design a user-centred driver information system that aimed at minimising congestion related problems in major cities in Malaysia.

Objectives 1 to 3 were intended to gain more knowledge regarding several essential issues before the so-called information systems are being developed. Issues such as information that drivers require, how and the timing to present the information are needed to be fully understood especially by local researchers. Thus, it is appropriate to conduct a study regarding local driver information needs as their needs might be different compared to other drivers, e.g. the U.S. or the U.K. Different culture and environments may trigger different sets of information requirements. Moreover, some systems, e.g. route navigation systems are already in existence in the U.S. or the U.K., while Malaysia has none.

Objectives 4 and 5 provided new areas that need to be explored in relation to the development of some mechanisms or systems that aim to assist drivers when travelling to unfamiliar destinations. These objectives served as a starting point for other studies to be conducted in local conditions/environment because there have been no studies reported so far in Malaysia regarding these two objectives. For example, objective 4 aims at determining the criteria that drivers use when choosing routes for different types of trip purposes. This information could offer more insight toward Malaysian drivers' route choice selection criteria. In addition, objective 5 could provide new areas that need to be examined by local investigators. Information gathered would enrich other investigators knowledge.

Objective 6 was covered in the experiment in relation to the presentation of traffic information (via radio broadcast station/audio) to the drivers. It was intended to use traffic information presented by a commercial radio broadcast station for several reasons. First of all, some of the motorists had experience of it especially commuters during their commuting trips. Secondly, because of non-availability of important equipment, e.g. simulators, visual traffic information (i.e. in-vehicle material/systems), the study could only employ the audio traffic information based upon commercial radio broadcast station. Thus, it is hoped the information collected could be used in designing the content of traffic messages in order to be presented to the target audiences.

In conclusion, the study carried out in this thesis is new to Malaysia especially regarding several aspects such as drivers' information requirements, wayfinding, route planning and route choice criteria. It is hoped that the information gathered through this study could help the responsible agencies, e.g. Ministry of Transportation and Public Works in developing some systems or mechanisms to assist drivers to counter congestion.

2.5. Methods Employed

The methods used in this study can be divided into three. The first part deals with the preliminary study, the second part briefly presents method used for the main study, i.e. interview survey, and the final section discusses the experimental work.

2.5.1. Preliminary Studies

Methods employed for the preliminary studies were group discussions, exploratory interviews, postal and interview surveys. The reason for employing various methods in the initial stage was to gather a variety of types of information, which could be used as guidelines in conducting a major study. This is because different set of methods could bring out different kinds of information as shown in previous studies (e.g. Penttinen et al., 1996; Streff & Wallace, 1993). Thus, based upon this assumption, the investigator employed variety approaches in order to elicit relevant data for the study.

Focus Group Discussion: This method was aimed at investigating several issues

- opinion and experience when involved in congestion,
- knowledge regarding new technologies in vehicles, e.g. motorists information systems.
- motorists' information requirements.

This method was used because of the need to explore some new issues, e.g. respondent's opinion and experience when involved in traffic jams, as there are no reported study or available information regarding these issues in Malaysia. In addition, the focus group technique was employed due to its advantages of gathering firsthand knowledge regarding new issues.

Exploratory Interview: The second approach used in the preliminary study was an exploratory interview. This method also investigated similar issues as with the focus group discussion. For example, the method was conducted in order to investigate:

- information requirement and
- new technologies regarding motorists information system.

In addition, interviews were also held with government and research institutes regarding their perspectives on the problems of congestion and plans to minimise the problems. Moreover, this technique was employed in order to supplement the information gathered from focus groups discussion. It was assumed that information gathered from variety types of subjects could enrich the investigator's knowledge regarding the issue of driver information requirements. (Confidential information gathered during the study has not been reported).

Postal Survey: Information from both studies, i.e. focus group and exploratory interviews were used in developing the postal survey. This study used questionnaires, which aimed at investigating information requirements. In addition, the postal survey also aimed at exploring the issues regarding the timing and method to present the information. The survey asked the audience on the type of information they required when dealing with congestion.

The use of a postal survey was to see whether all the relevant information could be gathered. The postal survey also helped the investigator in terms of devising a plan to sample subjects for the main study. The postal survey was employed because of the need to gather relevant material/information concerning the issues and other new aspects of the study, i.e. timing to present the information.

Interview Survey: Information from all three previous approaches was used in developing the questionnaire for the use in the interview survey. This survey used interview technique which aimed at eliciting information concerning driver information requirements. In this study, drivers were asked regarding their commuting trips information requirements (i.e. from home to work and vice versa) and unfamiliar trip information needs. The use of the interview survey was to test the reliability and validity of information gathered from the other methods. The interview survey also aimed at comparing the effectiveness of the methods used in the preliminary study.

In conclusion, the use of these various methods enabled the investigator to gather information regarding the main issue being studied, i.e. information requirements. There is also evidents from the literature that different procedures would come out with different findings. Thus, it was assumed that the use of various approaches could enrich this thesis material regarding drivers' information requirements. Besides that, the need for a variety of techniques was supported by the novelty of the research, where as far as Malaysia is concerned, no such study or report has ever been conducted. The use of various methods in the preliminary study enabled the investigator to assess the advantages and disadvantages of the methods in order to choose which method should be employed for the major study. The preliminary studies are to serve as the background for collecting data for a larger sample. Chapter 4 focuses upon the preliminary study.

2.5.2. Main Study: Interview Survey

Based upon the findings and information gathered from the preliminary study, it was decided that an interview survey should be used as the method to collect data for the major study. An indication from the preliminary study showed that an interview survey can attract a large number of participants compared to the postal survey where the response rate was 30%. The interview survey was also selected because of the need to explain technical terms such as route guidance, VMS (Variable Messages Signs) and advisory radio to respondents. In addition, it is more appropriate as it reduces the non-response attitude, a situation most likely to happen in a postal survey.

The questionnaire comprised several issues, for example:

- issues such as information requirements,
- timing and method to present the information,
- route planning & wayfinding strategies, and
- route choice criteria.

In conclusion, the interview survey was selected as being most suitable compared to other methods employed in the preliminary studies. Chapter 5 provides the explanation of the main study.

2.5.3. Experimental study: Presentation of Traffic Messages

The need for traffic information was upheld in the survey and so an experimental study was conducted to investigate in more detail the behavioural issues when presenting different types of traffic messages concerning congestion to drivers. No information was available on the reaction to certain message types from the drivers who actually will use this system. Therefore, this experiment served as a pioneer in investigating Malaysian driver's reaction toward traffic messages. There is no reported study or available material so far regarding these issues.

This was a simple experiment, which explored behavioural issues such as driver's decision, content of traffic messages (i.e. important elements of traffic messages) and traffic messages preferences when drivers were given several traffic messages on congestion. The experiment took place in a laboratory where respondents were presented with traffic information regarding congestion. They were asked to listen to the traffic information and to answer questions regarding the traffic information that they have heard. In the experiments, verbal mode of presenting traffic messages was used. The reason for using this kind of technique was based upon the results of the interview survey that revealed respondent's preference for information to be presented by commercial radio. In addition, the preliminary studies also showed that some drivers in most cases have the experience of being informed by commercial radio. The experiments also served as the starting point for other studies undertaken subsequently to investigate behavioural response when given several traffic messages to drivers with the use of variety of modes in presenting messages. Chapter 8 presents the study on the respondent's behavioural response.

2.6. Chapter-by-chapter summary

The first chapter describes the consequence of an essential item of modern society: motor car. The problems range from congestion to pollution. However, one of the important issues raised in the Chapter 1 was the use of new technologies in alleviating the above problems, i.e. congestion. This new technology also has its limitations. For example, there is a need to resolve interrelated issues concerning what information do drivers need, in what format should the information be presented and when do drivers want the information. The first chapter also describes other issues which need to be investigated in relation to the developments of the so-called user centred driver information systems, i.e. navigation and route choice criteria.

Chapter 2 presents the aims of the study. It lists the aims and specific objectives of the study. It also describes the rationale behind the aims of the study. The chapter also outlines briefly the methods employed in this thesis.

Chapter 3 reviews the literature of relevant topics, i.e. motorists information systems, the timing to present the information, method to present the information, navigation strategies which comprised wayfinding and route planning and finally on route choice criteria.

Chapter 4 reports a preliminary investigation of issues regarding the driver's information requirements (Study 1). Methods such as group discussion, exploratory interview, postal and interview surveys have been employed. Various topics were investigated such as information requirement and planning a route to an unfamiliar destination.

Chapter 5 provides the rationale for the main empirical work of the thesis (Study 2). An interview survey among commuters is described. The chapter also describes the survey sampling, surveys procedures and analysis. The results are presented in Chapter 6 and discussed in Chapter 7.

Chapter 6 presents the results of the interview survey (Study 2). Results are discussed in terms of the aims of the study. Results on information requirements, strategies that drivers used to navigate to unfamiliar destinations were also identified. The criteria that drivers prefer to use for selecting a route for different types of journey are also presented.

In Chapter 7, the results of the interview survey are discussed. The discussion examines these results in relation to the research literature and thesis aims. It first provides a description of information that drivers required. Route navigation strategies are also considered in relation to route planning and wayfinding systems. Finally, the discussion regarding route choice criteria is presented.

Chapter 8 presents an experimental study (Study 3), which is aimed at investigating behavioural issues related to the presentation of traffic messages about congestion.

Several issues were investigated such as the driver's response and traffic message contents (i.e. important elements of the traffic messages). The chapter also provides a discussion on experiment.

Chapter 9 is a summary of the research. The objectives are again re-examined in relation to the results of the preliminary studies, interview survey and experiment. The chapter summarises the main conclusion of the thesis. Contributions to knowledge and paths for future research are discussed. The final chapter ends with some conclusions.

2.7. Chapter Conclusion

Driver's information requirements in Malaysia have not been fully investigated. Limited knowledge has hindered the acceptance of driver's information systems by the target audience. In fact, some systems in the market do not reflect information required by the drivers. Therefore, there was a need to do a research to investigate driver's information requirements especially in a newly developing country, such as Malaysia. In addition, this thesis is also interested in investigating several new issues that have never been studied before, i.e. navigation strategies and route choice criteria. The study collects data on local drivers' needs and enriches local (Malaysian) investigators knowledge concerning aspects of driving and the driving population.

Chapter 3: Literature Review

3.1. Chapter Summary

This chapter is aimed at reviewing literature relevant to the study. It discusses the literature on motorists' information studies. The studies comprise most current and relevant information on motorists' information requirements study. The chapter also discusses literature concerning navigation strategies used by drivers and route choice criteria employed by motorists for the purpose of choosing a route to a particular destination.

3.2. Introduction

Road transportation in the world today is undergoing a fundamental modification. Advancements in information technology and telecommunications have been hailed as a means of alleviating some of the negative aspects of the motor car (Boyce, 1989). Various new technologies that could help motorists, transportation authorities and fleet operators are being developed at a great pace, to make better use of their vehicles and the highway network. With the rising of urban congestion levels world-wide, these advances/new technologies which could help minimise the congestion problem are important.

Growing concern regarding road transportation problems has led to a number of research, development, and demonstration initiatives throughout the world which are associated with the developments of new technologies in vehicles. These initiatives include the U.S. Intelligent Transportation Systems (ITS), European programs such as DRIVE (Dedicated Road Infrastructure for Vehicle Safety in Europe) and PROMETHEUS, and Japanese programs such as RACS and AMTICS. These initiatives cover a wide range of technologies, such as traffic management and control systems, driver information systems, and automated vehicle control systems.

This new technology is generally referred to as Intelligent Transport Systems (ITS). The goals of these technologies are to use the available road capacity more effectively, promote more efficient use of the existing highway and transportation network, make significant improvements in mobility, highway safety, and productivity by building transportation systems that draw upon advanced electronic technologies and control software, and decreasing the environmental costs of travel.

Galer (1995) indicated that these systems can be broken down into several categories which :

- "directly impinge on the driving task" - e.g. collision avoidance, intelligent cruise control, lane keeping,
- "provide information relevant to component of the driving environment, the vehicle or the driver" - e.g. traffic and travel information, vision enhancement, route guidance/navigation,
- "are unrelated to driving" - e.g. telephones, and office based facilities, such as e-mail, fax and web browsing capabilities.

Although, these new technologies could give benefits to its end users, they also have potential limitations. The problem is that the technology was, and is being, created primarily with the motivation to create applications for new technology (e.g., global positioning satellite; Owens, Helmers & Sivak, 1993). This technology driven approach often gives little consideration to the characteristics and needs of users. Failure to consider the characteristics and needs of all user groups raises concern because the technology may hinder instead of assist driving. ITS will most likely burden the driving task by increasing the amount of information that has to be identified, perceived and responded to (Stamatiadis, 1993).

There exist numerous human factors issues concerning driver information systems. Figure 2.1 shows several key human factors themes that were investigated in developing driver information systems.

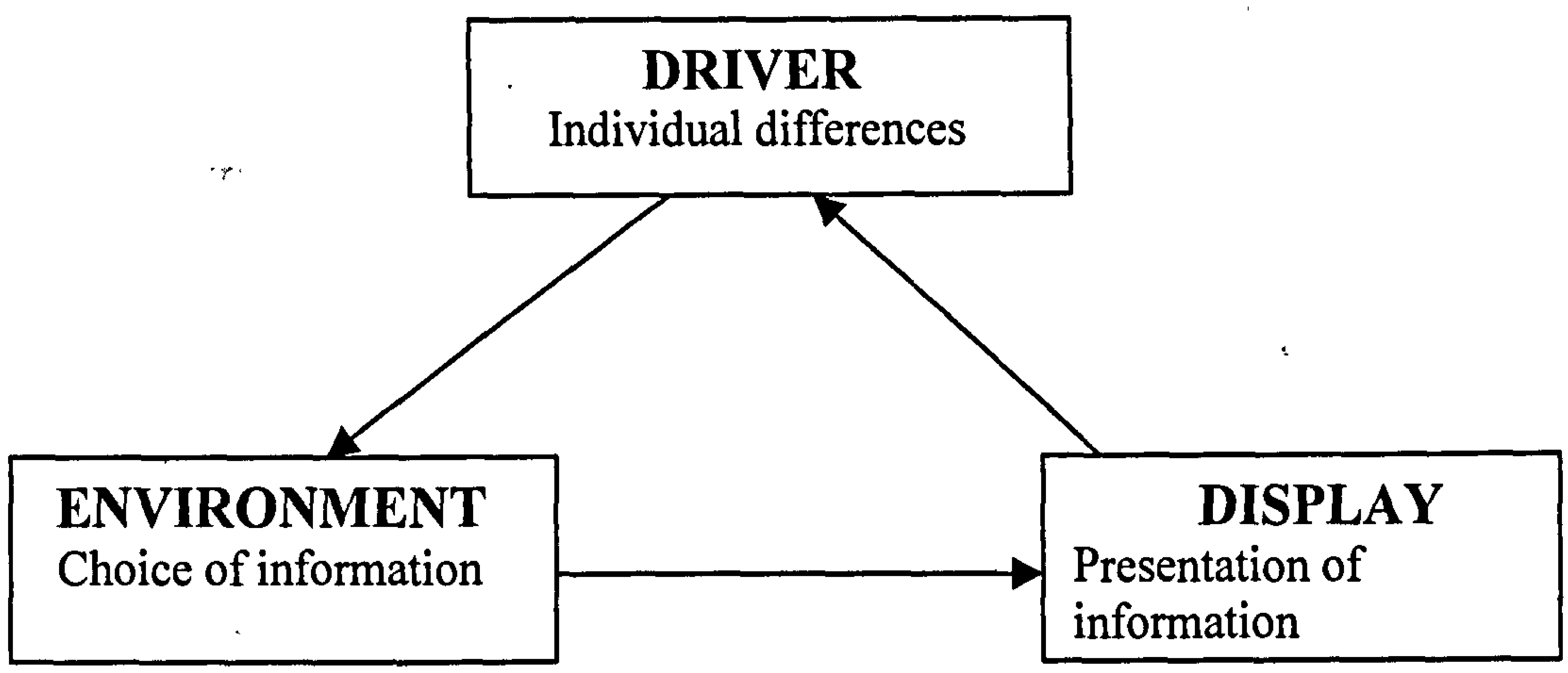


Figure 3.1- Key human factor research themes for Driver Information System

There are three main issues which need to be explained further. For instance:

- The choice of information - This constitutes the main focus of the thesis, and can be referred to as the 'what' question. A driver information system has to decide what information to provide for aiding drivers in several situations, for instance, when deciding to divert to an alternate route.

- The presentation of information - this can be referred to as the 'how' and 'when' questions. Environmental and other information has to be presented to the drivers via a display, for example visual or auditory modality and at what time should the information be presented, e.g. before departure, en-route to destination and other.

There have been a large number of empirical studies addressing information presentation issues, notably the choice and the format of information. Nevertheless, all the studies reviewed in this chapter were significant in term of showing what they have achieved in determining the appropriate information to be delivered to drivers. However, other factors such as individual differences which refers to the 'who' question might influence what kind of information that drivers might need. For example, Barfield et al (1989) has pointed out that drivers' information needs are not homogeneous. Evidents show that different drivers may have varying requirements from a system. For instance, a dispatcher may require the fastest available route whereas a holiday- maker may want to use the scenic roads. In addition, the needs of an individual driver may also vary over time. For instance, an expert user of a system may require much less detail than a novice user. Furthermore, drivers may require little information while travelling in a highway, but much more detail when entering a city centre or nearing their final destination. Thus, this thesis intends to investigate drivers' information requirement in order to develop motorists information systems. This study concentrates upon driver information requirements in Kuala Lumpur, Malaysia.

3.3. Overview of Driving Tasks

In theory, the driving task could be divided into several different conceptual levels with each level requiring different skills and control from the driver. Figure 3.2 shows the descriptions of driving task elements (based upon Michon, 1984 & Janssen, 1979). At the highest level, i.e. strategic level involves activities in regard to travel decisions, e.g. what route to be taken. The second level, i.e. tactical level consists of the planning of concrete manoeuvres throughout the route which involves interaction with the immediate environment, including other road users. An example of this level is a left or right turn which refers to specific planned manoeuvres. Whereas at the lowest level is control which involves highly automated motor execution of the tasks planned at the higher levels, e.g. applying the brake or gear shifting.

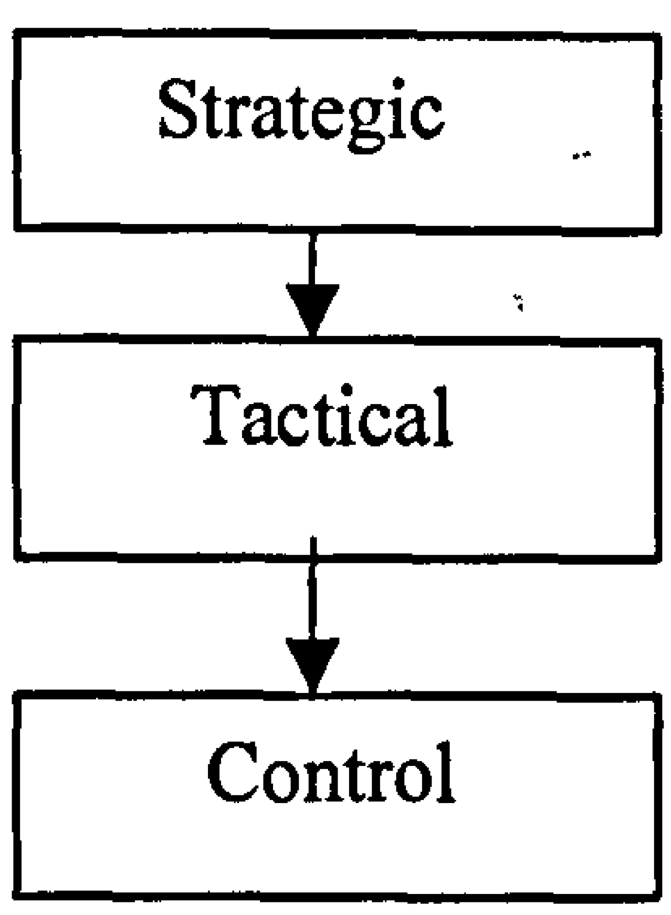


Figure 3.2 - Hierarchical element of the driving task

The above diagram certainly has some influence regarding what kinds of information that drivers require and information processing. In fact, these three levels of driving task are characterised by three modes of information processing proposed by Rasmussen (1987). For instance, knowledge-based processing relies on a conscious analysis of the situation (e.g., route plan). Activities carried out at this level employ considerable resources on the part of the driver. Rule-based functioning applies to familiar situations where pre-learnt rules or 'know-how' for co-ordinating behaviour can be applied (e.g. lane change). At this level, medium resources are utilised in activities. Finally, skill-based processing involves a highly practised, automatic behaviour without conscious control (e.g. steering a car). Minimal resources are required for this level of behaviour.

3.4. Studies of Motorists' Information Needs

3.4.1. Introduction

There are many studies regarding drivers in general in the literature which focus on variety of aspects. For instance, some studies stress accident risk, physiological measures/changes, whereas others emphasise behavioural changes. Research regarding motorists' information requirements has been done quite recently together with the development of the new technologies in the vehicles. However, these developments do not guarantee that the products developed specifically for the use of the motorists' were based upon their requirements or needs. Therefore, studies concerning information requirements should be done more in order to have concise knowledge regarding motorists information needs for different situations, e.g., when using a congested route or diverting to an alternative route. This chapter presents some of the most current and relevant information on motorists' information requirements, wayfinding and route choice. In these sections, the literature regarding motorists' is divided into several parts. For example, the first section discusses the information requirement study, followed by methods to present the information required by the drivers and finally timing to present the information to the commuters who require it. Some researchers have focused upon all the aspects and some only emphasise on one aspect. Thus, some of them are cited several times in the three sections.

3.4.2. Information Requirements

Studies concerning motorists' information requirements were done by a number of researchers using several techniques which gave a lot of information/material regarding information needs of motorists'. In addition, these studies serve as guidance for other researchers, in investigating motorists' information requirements. The studies give indications in determining what methods to be employed, advantages and disadvantages of the methods used, and finally the contributions in term of findings and context of developing instruments and aspects to be investigated.

Based upon an hierarchical driving task model which introduced the three levels of the driving task: strategic, tactical and control, the drivers informational needs can be assigned to the two higher levels, e.g. strategic and tactical levels. At the strategic level, a driver requires information such as traffic conditions, estimated journey time, availability of parking places, etc. in order to make overall route decisions. Researchers have addressed the role of these different information types as criteria for route selection (e.g. Wallace & Streff, 1993; Bonsall & Joint, 1992).

At the tactical level, the needs are quite different as here drivers require navigation information such as direction of movement, landmarks, road sign, distance, and road layout to help decide where and when to turn. The relative merits of the different information types at this level of the driving task are critical to the usability (especially safety-related aspects) of an information system.

The study of driver information requirements can be broken down into those which have aimed to generate suitable information types and those which have tested particular information types. For example, Haselkorn et al. (1989) conducted a study which investigated motorists' activities and behaviour and identified distinct types of commuter and their use and preferences for motorist's information. They found (N = 3,606), commuters could be classified into 4 distinct groups, which were:

- Route Changers (RC = 744) - willing to change route when they received traffic information.
- Non-Changers (NC = 844) - unwilling to change in everything, e.g. route, mode of transport or time to travel even though they were given traffic information.
- Route and Time Changers (RTC = 1,446) - they are willing to change both route and

time of travel.

- Pre-trip Changers (PC = 572) - this group is willing to change modes of transport and would make more changes before leaving their house.

The implication from the study by Haselkorn et al., is that commuters' population cannot be treated as an homogenous population that has similar information needs. In addition, their results also show that commuters can be categorised into 4 groups which have different information requirements, and therefore their needs should be treated accordingly. The finding also show that there were some drivers who would use the information given to them in their commuting trips, e.g. RTC and PC. Consequently, the designers of information systems need to investigate further these four different groups regarding their information needs as they might have different requirements for the development of the information systems. Haselkorn et al's, study demonstrated the variety of drivers' needs which should be addressed first before the system goes down the production line.

Streff and Wallace (1993) concentrated upon drivers information needs particularly those requirements and needs that are not yet well understood by the Intelligent Transport Systems (ITS) community. They conducted a postal survey of members of a motoring organisation in Michigan (N = 2764). The survey aimed at three different types of driving, which were:

- commuting trips,
- non-commuting trips in a familiar environment and
- trips to an unfamiliar destination.

Respondents were asked regarding types of information that they would require when deciding whether or not to divert. There were 33-information bits which drivers' thought were important in inducing their decision whether to divert. These information were:

- Delay time on original route
- Predictability of delay on original route
- Level of congestion on original route
- Arising problems if lateness occurs
- Type of problem

- Condition of alternate route
- Congestion on alternate route
- Ease of access to alternate route
- Distance to problem
- Time on alternate route
- Repair of alternate route
- Time of day of trip
- Directness of alternate route
- Length of alternate route
- Time set aside for trip
- Location of alternate route
- Familiarity with alternate route
- Difference in travel time between routes
- Availability of directions for alternate route
- Road type of alternate route
- Number of other cars taking alternate route
- How stressed at the time
- Speed limit(s) on alternate route
- Day of week of trip
- Number of stops on alternate route
- How tired at the time
- Similarity of original and alternate route
- Types of vehicles on alternate route
- Type of areas of alternate route
- Presence of railroad crossing on alternate route
- Number of police patrols on alternate route
- Scenery on alternate route
- Problems that will arise if arrival is early

They came out with different types of traffic information that drivers required in different types of journey, e.g. commuting vs. unfamiliar trips. In addition, their findings reveal a relatively wide range in the ratings of individual information bits, but no information bit averages above the very important range, suggesting a lack of universal agreement on what constitutes essential information. The above list of types of information was needed should the drivers decide whether or not to divert to an alternative route. It is also along the same line with the study of Haselkorn et al (1989) which shows that a driver may have different requirements regarding traffic information. Therefore, the designer of motorists information system need to focus on this issue, e.g. different kind of trip or drivers may influenced the needs for different kinds of information. The indication from their study is that drivers would require different types of information instead of just a single piece of information on which they must based their decision. In addition, some information was considered important which drivers could use to make a decision whether or not to divert. For example, in the unfamiliar-areas survey, respondents would rate "the availability of directions for alternative route" as the most important which may suggest that for drivers in an unfamiliar area, information such as congestion levels and travel times are not sufficient for making diversion decisions. Thus, one may conclude that inadequate information on an alternative route may prompt drivers to remain on current, congested routes rather than driving in unfamiliar areas.

Wallace & Streff also found that respondents ranked information such as "characteristics of delay on the original route", "characteristics of the alternative route" and "delay characteristics of original route in different types of survey" (i.e. commuter survey and familiar are survey) as important. The results may suggest that commuters may have a propensity to divert from a congested route whereas non-commuters travelling in familiar areas may want to know more about the route that they would follow if they choose to divert. In fact, respondent's willingness to divert from unusually congested routes depends upon the type of trip made. Driver diversion decisions also vary by the type of trip made. This may suggest that driver's decision whether or not to divert is related to the trip that he makes at that particular time. Thus, if they need to arrive on time at their destination, they most likely have to make a diversion in order to reach their destinations as expected.

Streff & Wallace's (1993) study also gave several insights in order for us to understand different kinds of information that drivers need. For example, many of the most needed information items (i.e., congestion levels and route guidance) are ideal candidates for inclusion in drivers information systems. It is because there are differences by trip type in what information needs are important based on driver's perception. Thus, it is clear that adequate drivers information systems must be designed with the capability of providing a large amount of information. The systems should add a special function which gives drivers freedom to select which pieces of information will be accessed at any given time.

Daniels, Levin and McDermot (1976) conducted a home-interview survey and found that drivers are fond of traffic information given to them by commercial radio station. This may suggest that drivers probably prefer the idea of receiving different traffic information which they think are important to their driving task. In addition, they also found that drivers would divert to another route based upon the information that has been presented to them by the commercial radio. Thus, drivers may perceive the information given to them as accurate and they based their decision to divert on the information given to them by the commercial radio station.

Their study also shows that drivers consider both traffic conditions and road conditions as important elements in helping them to make a decision, e.g., when to travel and use the route. Evidents from the above findings revealed that at least two types of information are considered as important. In addition, information on traffic information covered a variety of messages such as amount of traffic, traffic flows and others that could influence drivers decisions. However, respondents also indicated that traffic information should be more accurate and timely, especially at reporting traffic conditions. Past research has shown that most drivers prefer to have messages regarding the location, length and degree of congestion as an indicator of traffic condition (e.g. Heathington et al., 1970). Thus, it can be said that drivers in Daniels et al., study consider traffic information as important because of the variety of messages it could offer.

Daniels et al., also suggested that traffic conditions should be reported in a consistent manner in order to decrease the possibility of driver misinterpretation of information and its accuracy. This may suggest that due to the variability or fluctuations in the nature of traffic, the designer of information systems should be able to design a system that is capable of giving predictive type of information to drivers. It could reduce various unwanted actions from the drivers, such as uncertainty. Indeed, a study by Kantowitz et al., (1997) shows that if information is given with an accuracy of 71%, drivers would be able to make better decisions. Thus, it is better to give accurate and adequate information rather than otherwise.

Daniels et al., study also emphasises the importance of commercial radio in presenting traffic information that a driver requires. It is similar to the findings of Wallace & Streff (1993). This may suggest that commercial radio is a dominant method to present the information that drivers require. Wallace & Streff also indicate that most of their respondents obtained traffic information from commercial radio. In fact, both investigators agreed that their respondents find broadcast information to be helpful especially in planning routes. However, there are also some negative aspects of commercial radio, e.g. information is received too late and may contain irrelevant information.

Nevertheless, Daniels et al., suggested that the commercial radio traffic report is an effective component of any driver information system. This may imply the importance of commercial radio as the main method to present traffic information. However, one question arises regarding the kinds of information that should be presented. Thus, further study should be done in investigating what kind of traffic information should be presented to drivers. In fact, their study which was done 20 years ago may not be suitably applicable to the present condition in which new technologies have been developed rapidly in term of providing traffic information to drivers, e.g. route guidance systems. Moreover, Daniels et al., study is helpful in determining information that drivers think useful in several ways, e.g. deciding to depart and choosing a route to drive.

Penttinen, Louma and Rama (1996) conducted a study investigating what kind of information Finnish drivers needed and would like to receive, which means of communications they would prefer and how the information influenced them. By using a telephone interview method, they interviewed 1,002 drivers. They found that the most popular sources of information were the Variable Message Signs (VMS), television, newspaper and radio. The drivers also considered Traffic Message Signs (RDS-TMC) and information monitors at service stations as important. They also found that road maps, road works maps, television text and Radio Data

System important. The variety of sources that drivers indicated capable of presenting traffic information may suggest that drivers will use several sources of information when searching for traffic information. The drivers also indicate that all information sources that are mentioned above were more important for infrequent than frequent trips. The most experienced drivers wished to receive more on-the-road information compared to the novice drivers. On frequent trips, e.g., commuting trips, respondents in Penttinen et al. (1996) study estimated information that were very important for their trips varied according to the following factors such as weather, road construction, the fluency of traffic flow, congestion and accidents and routes, travel times and schedules. The above list suggests that drivers would like to have a variety of information just for commuting trips. This is also similar with other studies, e.g. Spyridakis et al (1991), Daniels et al (1976) and Streff & Wallace (1993) in which they found drivers did require several information sources. Thus, we could conclude that drivers information needs could not be treated as having similar requirements.

Whilst, for rare trips, i.e., unfamiliar trips, the respondents stated that they required information on weather, road construction, the fluency of traffic and routes, travel times and schedules. Based upon the above lists, we could see some similarity regarding the information that drivers required even though the types of trip differ. This would suggest that although the trips were of different purposes, the needs were the same. It might be due to the importance of the information based upon the driver's opinion. For example, when road and weather conditions are concerned, drivers appreciated information like slipperiness, ice, slush and snowfall. Drivers also indicated that roadwork information should contain messages about alternative routes and the length of roadwork sections. Indeed, information about lowered speed limits and the quality of the pavement in the road work section were also relatively important. Furthermore, with regard to a smooth traffic flow, drivers considered most important the information on alternative route and the duration of the delays. Finally, regarding routes, travel times and schedules, they considered information on speed limits and the amount of slow traffic as the most important.

These findings clearly show that different elements of traffic information were needed by drivers in different kinds of trips, e.g. frequent trips (commuting trips) or infrequent trips (unfamiliar trips). Thus, this may suggest that the information given to the drivers should contain various types of messages on which drivers would base their decision. However, one may argue the suitability of presenting these kind of information to the drivers, as the road environment itself is abundant with information. Therefore, designers of information systems should be able to develop systems that operate when needed, i.e. drivers should have the final say in making the decision.

Mannering, Soon-Gwan, Ng and Barfield (1995) conducted a study which aimed at investigating private travellers' preferences toward in-vehicle information systems. They found that a traveller's socio economics, habitual travel patterns, commute congestion levels and attitudes toward in-vehicle technologies are significant determinants of traveller's important ratings of in-vehicle system information. They found that drivers would like to have information on alternative routes and road condition. The findings could be divided into two types of drivers, (a) travellers who often drove on major highways and did not want the above information to be given to them in advance compared to the travellers with flexible work hours and (b) drivers who made their route choices at home or workplace preferred to receive this information in advance. There may be several explanations of different timing of information to be given to its end-users. For example, as a result of being frequent users of highways, travellers may develop a high familiarity with their routes and thus a better awareness of alternative route and possible variations in roadway conditions. However, for the latter, it is clear that having such information beforehand can help travellers make their decision with regard to work start/finish times and route choice.

Apart from information on alternative route and road conditions, drivers also need information on weather conditions. Findings from the studies revealed that there were differences among the drivers regarding the timing of the above information. For example, travellers with a high number of familiar alternate routes preferred to have weather information provided to them in advance. This may suggest that weather affects route choice and that the route-choice decision may be made close to the trip origin. In contrast, travellers who made frequent changes in their departure time indicated that weather information need not be provided as far ahead. It is possible that such individuals adjust their departure time frequently to avoid congestion and since they end up driving at less congested times, the impact of weather conditions is less critical. Alternatively, departure time changers may have shorter commutes and thus require the weather information less far in advance. They also found that individuals who commute to their home between 5 p.m. and 6 p.m. prefer to have the weather information further in advance. This is likely to be due to the fact that weather can have a severe impact on traffic during this congested time period and thus travellers prefer to have information provided far in advance. This was similar in cases where respondents in the research focus groups mentioned that weather or rain could cause chaotic congestion.

Drivers also require information on regulatory and warning signs. Mannering et al., (1995) study reveals the importance of regulatory and warning signs information to drivers especially during the morning trip (i.e. home-to-work) when the traveller is facing a constrained arrival time and such information could influence the departure time choices. This assumption could be supported by the morning and evening departure time indicators that show home-to-work commuters (7-9 a.m.) prefer that the information be provided further ahead and work-to-home commuters (5-6 p.m.) prefer fewer ahead-miles, e.g. lower preference in terms of distance).

From the studies, we could conclude that there were other factors that could influence drivers' decision to have several types of information. For example, drivers who had flexible working hours and decided their route choices at home or at the workplace preferred to have information on alternative routes and road conditions further in advance or before their departure or upon reaching their destination. This may suggest the importance of information systems to differentiate various types of drivers' requirements. Secondly, drivers would need other types of information that also comprised other elements, similar in the study of Penttinen et al (1996). However, different categories of drivers were investigated by Penttinen et al (1996) and Mannering et al., (1995), e.g. commuters and commercial drivers. Thus, based upon both studies, it was clearly shown that different types of drivers may require different kinds of information. In fact, one may conclude that different trips may also require different kinds of information (e.g. Streff & Wallace, 1993). Their study also acknowledged other past studies that revealed drivers' needs for a variety of types of information. Thus, motorists could not or may not represent populations which have similar needs. In addition, this and other studies also enrich local Malaysian investigators knowledge regarding what kind of information is important for certain types of commuters and journey. It is because different types of journey may influence the needs for different kinds of information.

Spyridakis et al. (1991) try to identify freeway commuters who experience normal traffic congestion and have access to various forms of traffic information in Washington. They conducted a postal survey in order to investigate their aims. The questionnaires were distributed on a site of the freeway in downtown Seattle, and approximately 3,893 drivers participated. Based upon their study, Spyridakis et al. (1991) found that most drivers would divert to the alternative route based upon the influence by traffic information, congestion and time of day. Drivers would divert to known routes early compared to unknown routes. Spyridakis et al., finally concluded that traffic information could influence drivers' route choice and departure time, e.g., to and from work.

The importance of Spyridakis et al., study was the identification of various information needs among their sample. This is similar in other studies, e.g. Daniels et al., (1970), Streff & Wallace (1993) which also found the needs of various types of information by commuters. Another importance of their study was the findings about different timings and mode in presenting the information. They found that some information was best presented before the trips and others during the trips. This may suggest that different sets of timings to present information must be acknowledged. In addition, other studies e.g. Mannering et al., (1995) also acknowledge different sets of timings to present the information. Mannering found that some information need to be given at a certain time, e.g. much earlier in order for the driver to make a decision. Most of the drivers would like to receive the information before driving and the majority of them would prefer to use commercial radio as the essential mode to pick up the information. This shows that it is appropriate to convey traffic information before drivers start their journey. It is because drivers could modify their needs such as change mode of transport or departure time. In addition, commercial radio was found to be the preferred medium in presenting the traffic information because of its nature of that it can attract many listeners compared to other types of mode (e.g. Wallace & Streff, 1993).

The traffic information given to drivers in Spyridakis et al., study was considered to have some influence in their decision to divert to an alternative route. This may suggest the importance of traffic information to the commuters. Traffic information particularly influences female drivers' pre trip decisions about departure time, transportation mode and route choice. Thus, we could say that the availability of traffic information on commercial radio might strongly influence some drivers in several important aspects, e.g. route choice. Other studies have also identified the preference for up-to-the- minute traffic information and specifically those provided by radio (e.g. Dudek et al., 1971). This shows the importance of commercial radio in determining and influencing drivers behaviour. However, their study did not leave out other types of mediums, which also influence drivers' decision, e.g. mobile phone, VMS, and in-vehicle systems. These media have their merits and drawbacks (which will be discussed in the next sections).

Shirazi et al. (1988) investigated commuters' attitudes toward traffic information and route diversion. They asked drivers questions regarding their commuting trip, factors affecting route change and traffic information. They conducted telephone interview in Los Angeles, where 400 commuters participated. They found that 71% (N=400) participants knew of an alternative route that they could take to work, which indicates that the idea of taking alternative routes may not be that uncommon to Los Angeles commuters. Indeed, Spyridakis et al., (1991) demonstrated that drivers in Seattle also knew more than one alternative route to their destination. This may suggest that drivers may divert to known routes rather than unfamiliar ones. However, there was also other factors that influence drivers on whether or not to divert to an alternative route, e.g. types of route and drivers characteristics (Abdel-Aty et al., 1997).

Shirazi et al., also found that commuters in stop-and-go traffic were more likely than other commuters to change routes. The most frequently cited factors that made them change routes were traffic reports (30%), followed by personal experience (20%) and having to arrive on time (17%). The overall result shows that commuters need timely and accurate traffic information (27%), more frequent reporting (15%) and better use of electronic freeway messages signs (VMS) (8%). The implications from Shirazi et al., study was that traffic reports might prompt drivers to change route more often than other factors. Indeed, Khattak et al (1993) also made similar suggestions which claimed drivers may divert to another route based upon traffic information given to them by commercial radio rather than by using their own observation about the traffic condition. Thus, information presented by radio could influence drivers decisions. Indeed, the radio could be used as the basis for making decisions if several criteria were met. For example, in their study, drivers mentioned that the report should be as accurate as possible. This means that drivers need information that is credible, accurate and timely. The intended system should be able to focus or give information based upon the criteria that have been set up by it end users. Thus, the system should meet the needs of its users.

Allen et al. (1968) conducted a study to investigate drivers information needs by determining what drivers do while making a journey. They used verbal observation techniques in order to investigate the driving task (task analysis). They described that drivers' information needs can be classified into aspects such as:

- control information needs (i.e., steering and speed control),
- guidance information needs (i.e., car following, overtaking and passing),
- navigation information needs (i.e., trip preparation and planning and direction finding).

From the above lists, we could suggest that various kinds of information are needed by the drivers (according to the three aspects implied by Allen et al). For example, at the first level of needs, e.g. control information are needs which drivers might require to enable him to know the status of speed of their vehicle and speed of the traffic while driving. In addition, guidance information needs cover other aspects that a driver considers important. Finally, navigation information needs could enhance driver's knowledge with information on the traffic itself. For example, what route to take could be a source that helps drivers to reach the destination. In addition, various kinds of information required at these different levels, i.e. control, guidance and navigation imply the need to have diverse types of information. This information could help drivers in various situations such as criteria for route selection (Wallace & Streff, 1993).

The implication from the above list is that drivers at very specific levels require numerous kinds of information. Thus, the above list shows the different levels of driving which may prompt different kinds of information needs by motorists. It is also similar to the analysis of other researchers such as Rumar (1993) and Brown (1986) which distinguish the task of driving and the information that drivers require based upon the driving task itself. Rumar and Brown discussed the need for different information related to the task of driving. For example, some of them are:

- strategic tasks (choice of transport mode, time of departure)
- navigation tasks (to follow the chosen or changed route in traffic)
- road tasks (to choose position and course on the road)
- speed control (choice of speed in and before every situation)
- traffic tasks (to interact with other road users)
- rule compliance (following rules, signs)
- manoeuvring tasks (to handle the vehicle so the above tasks are reached)

The entire task requires different kinds of information. Thus, it is appropriate to suggest that drivers may require various types of information according to their driving task. Indeed, Berge et al (1992) has discussed the importance of both levels of driving and information requirements. This may suggest that at specific tasks, information is needed in assisting drivers to reach their goal, e.g. arrive at a destination. The importance of Allen et al's., study was the identification of information needs based upon the three levels of driving task. This may imply that there are various kinds of information that drivers need. Allen et al., finally concluded that drivers information needs must be satisfied in accordance with the objective of the highway system. The systematic presentation of information needed by the driver must take account of the processing channel limitation of the driver. It is suggested that the drivers should not be overloaded in terms of either attention-paying and load-shedding ability or information-processing channel capacity. Based upon Allen et al's., study we could say that in order to develop systems that are capable of presenting information to the drivers, the limitations of the targeted audience should be considered. It is because driving itself is an attention demanding task and developing a system that does not take into consideration drivers requirements or needs might jeopardise their life.

Caplice et al. (1992) studied the users' experiences with the traffic systems, the use of traffic information and route switching decisions made by the commuters. They employed a postal survey and detailed diaries for a two-week period. The questionnaires were mailed to 3,000 households randomly selected in an area of five zip codes in the Northwest section of Austin, Texas. Approximately 638 (21% of the original sample) participants took part in the survey. They focused upon three main aspects: screening questions, personal characteristics and commuting habits. The majority of respondents were male, between 30 and 44 years of age and virtually all (98.8%) used their own cars to commute to and from work and only 2.4% belonged to a carpool group. The average reported home-to-work trip time was just under 21 minutes and the return commute averaged slightly more at 24.4 minutes.

Their study revealed that commuters adjusted their departure time more for the home-to-work commute than for the return trip. A slightly higher fraction switched routes in the work-to-home commute than in the morning. Interestingly, a significantly larger fraction of commuters reported switching routes rather than time in the work-to-home commute. Relatively few commuters appeared to be willing to delay their departure from work. However, a larger fraction of commuters would adjust departure time than switch routes in going from home to work. The results suggests that considerations governing home-to-work commuter switching behaviour may be different from those governing the work-to-home commute. Similarly, different considerations may affect route switch versus departure time. They also found that the use of information, captured through the radio traffic indicator, exerted a significant positive effect on the propensity for switching in all cases with the exception of evening departure time switching. The indirect implication for motorists information systems is that users who receive such information tend to respond through path selection and may even adjust their departure time in the morning. Another implication from Caplice et al's., study was that the drivers used traffic information presented by radio in making route switching or diverting to another route. This was also consistent with Khattak et al's., (1993) study which revealed that drivers may divert/switch to other route based upon information on the radio rather than their own observation concerning unusual congestion on their regular route.

The understanding of drivers en route decisions are important for designing congestion-reduction strategies, particularly the Intelligent Transport Systems. Khattak et al (1993) conducted a study specifically to investigate factors influencing en route response to incident-induced congestion. The target populations consisted of automobile drivers who made repeated trips during times when broadcast traffic information was available to them. These travellers were intercepted at a sample of downtown parking garages during rush hours (7.00 a.m. to 10.00 a.m.). Mail-back questionnaires were distributed to commuters as they walked out of garages in the morning. A total of 700 questionnaires were received, representing a response rate of 33 per cent. Khattak et al., found that en route diversion behaviour was influenced by several factors such as:

- source of traffic information,
- length of delay,
- gender,
- travel times,
- number of alternative routes used,
- congestion on alternative route and
- stated preferences about diverting.

The drivers were more likely to divert when they received delay information through radio reports than when they observed the delay themselves. As a conclusion, Khattak et al., assume that real-time traffic information provides a basis for making en route diversion decisions, and drivers actually shift their route in response to radio traffic information.

The importance of Khattak et al., study is that it provides some insights in term of the importance of radio traffic information in determining diverting behaviour of motorists. A majority of automobile commuters evaluated radio traffic reports positively in terms of accuracy, timeliness and relevance. This may suggest that several aspects of the radio traffic reports were considered as important, which could influence driver's behaviour. For instance, the content or meaning of information was appropriate based upon commuter's perception. In addition, the accuracy and timeliness of information showed that the information was available whenever the traveller needed it, i.e. by updating real-time information frequently. Thus, based upon Khattak et al., study, it is suggested that to better satisfy individual's information needs, the Driver Information Systems should provide historical, real-time, and predictive information. Providing better quality traffic information can help motorists psychologically by reducing their anxiety and by allowing them to plan their travelling. Thus, information system designers should give particular attention to psychological benefits, which can accrue to users as well as benefits from improving their ability to perform certain tasks such as trip planning.

However, another key element regarding the diverting behaviour of commuters' is there could be other factors influencing their diversion decision. For example, the combination of both elements, i.e., information presented by the radio and factors that influence diverting behaviour could be a source in determining drivers route diversion decision. Past evidence shows that route attributes such as traffic congestion and variability in travel time may also influence driver departure time and decision to divert to alternate route (e.g. Abkowitz, 1981). This may suggest that designers of information systems should be able to distinguish a variety of needs and decisions made by the traveller when they face similar cases, e.g. when deciding whether or not to divert. The importance of Khattak et al's., study was that they identified the nature of other factors that could influence driver decision to divert other than traffic information given by commercial radio. One of the important issues raised by this study was the use of radio in influencing drivers decisions to divert. Indeed, this finding was similar to a study by Emmerink et al., (1996) which found that radio traffic reports might influence drivers decisions on route choice. This also shows the capability of radio traffic reports in reporting traffic information to drivers and most of the drivers listened to them as guidance in determining their action or behaviour (e.g. Spyridakis et al., 1991 & Shirazi et al. 1988).

Ng, Wessel, Do, Mannering and Barfield (1995) conducted a study to identify commercial driver and dispatcher requirements for advanced traveller information systems. The dispatcher survey was designed to identify the type of information that will help dispatchers effectively communicate routing decisions to the drivers, while the commercial driver survey was designed to identify information needed while driving. They employed a postal survey technique where a total of 348 questionnaires were returned representing a 3.3% response rate. The results show that 77% of dispatchers and 84% of commercial drivers would use ATIS if it was given to them and that commercial drivers who value trip safety were more likely to use an in-vehicle system. They also found that dispatchers who communicate with dispatched vehicles by two-way radio were more likely to use ATIS. This indicates that dispatchers are currently dissatisfied with current standard communication methods and view ATIS as providing them with significant improvements. In regards to the level of importance of ATIS features, the study found that commercial drivers were more likely to consider navigation and route selection features as being important while dispatchers regard road and traffic information as very important features of ATIS. An implication from their study was that it provides some valuable basis for the design and marketing of ATIS to commercial drivers and dispatchers. Indeed, similar findings in other cases, e.g. Streff & Wallace (1993), also show that different types of drivers and journey would use different kinds of information for their journey. Thus, future work should focus on the evaluation of an actual ATIS system in which commercial drivers and dispatchers have been exposed to it in order to measure the effectiveness of the systems to their performances. However, one could argue the lack of representativeness of the sample used in their study because of the small number of respondents who participated in the survey. However, the important evidence was that the different class of drivers, e.g. dispatchers and commercial drivers required different kinds of information for their journey.

Indeed, the majority of past studies on Advanced Traveler Information System (ATIS) information requirements have concentrated on automobile drivers and focused on:

- the analysis of the drivers' perspective in relation to traffic information (e.g. Durnad-Raucher et al., 1993)
- the investigation of route diversion decisions (e.g. Vaughn et al., 1992; Khattak et al., 1993),

- the identification of subgroups of potential drivers who would use ATIS (e.g. Barfield et al., 1990).

However, the importance of the Ng et al., study was to investigate information requirements by commercial drivers and dispatchers, which is limited, e.g. inadequate knowledge regarding their needs. Indeed, the findings were also similar to Stone & Ervin (1990) which found that communication between the driver and dispatchers was generally rated as important or very important among all respondents. Thus, as mentioned by Ng et al., (1995), dispatchers prefer to have communication, e.g. two-way communication. It is obvious that providing two-way communication between drivers and a control centre could bring several advantages, such as reliability or accuracy given by both parties to other drivers. Therefore, the ATIS systems should be developed based upon the needs of its end users, e.g. feedback or communication between the target users and information providers. Some category of drivers, e.g. dispatchers may need some form of communication that could highlight or inform of problems early before they face it. For example, dispatchers need confirmation that they are doing the right task.

Apart from the above studies, there are also other studies which were interested in determining driver information needs. For example, Berge et al., (1990) focused upon the introduction of a typology of information based on the combination of four categories and six levels of information. We have already seen that driving is an activity consisting of numerous tasks/decisions all based on information. The information drivers need to perform these various tasks/decisions can be divided into four main categories. There are as follow:

- *Basic information* which is vital for traffic safety and connected to the routine tasks of driving,
- *Regulatory information* concerning traffic regulations given by the road authorities to regulate the traffic in general and to guide or direct the individual driver's behaviour,
- *Additional information* which is useful and desirable for the driver because it may contribute towards making the traffic and individual driving more flexible, efficient and comfortable,

- *Service information*, which in principle is not directly connected to the driving task or general traffic conditions but useful for the driver related to the purpose of driving.

Table 3.1 shows the most important elements of the task of driving and the information objectives connected to the different information categories.

The table shows the variety of types of information that travellers require when making certain types of journey, e.g. commuting trips. There are four categories of information. Basic information refers to elements such as road, traffic, speed control and manoeuvring. In all these elements, there are other aspects which could influenced driver's action. For instance, different categories of traffic situations and speed control, which could comprise choices of speed. At another level, i.e. regulatory information that consists of rule compliance, e.g. following rules, signals and signs the drivers need all of these kinds of information before departing or while driving to their destination. Thus, we could say that travellers require a variety of types of information.

Table 3.1. Types of information

Type of Information	Basic Information	Regulatory Information	Additional Information	Service Information
DRIVER TASKS	* Road * Traffic * Speed control * Manoeuvring	* Rule Compliance	* Strategic (Planning/ decision making) * Navigation	* Driving purpose * Work
INFORMATION OBJECTIVES	Manoeuvring the vehicle in The traffic	Legal driving	Efficient and comfortable journey	Group specific

Apart from the four categories of information level, Berge et al., (1990) also indicated that there are other information levels which drivers would get information from. For example,

- at *vehicle level*, the drivers get information about the vehicle, e.g. the vehicle's technical specifications and information about the goods or passenger in the vehicle.

- at *trip level*, they get information about the trip; duration, destinations, routes, etc.
- at *road level*, the driver get information from and about the road and the immediate physical surroundings like location of bus stops, special lines for public transport and also road network information.
- at *traffic level*, they get information on traffic density, average traffic speed, congestion warnings etc.
- at the *infrastructural level*, they get information related to the physical environment and the infrastructure like available parking space, location of petrol stations, information about tourist attractions, hotels etc.
- at the *cultural level*, the drivers get information about customs, language and behavioural aspects in the area concerned.

The different information categories and the various information levels can be seen in combination. This combination and the information categories are the basis for a typology of information. Table 3.2 shows the information categories and information levels.

Table 3.2-The combination of information categories and information levels

	CATEGORIES			
Level	**Basic**	**Regulatory**	**Additional**	**Service**
Vehicle	*	*	*	*
Trip		*	*	*
Road	*	*	*	*
Traffic	*	*	*	
Infrastructure			*	*
Cultural				*
The useful combinations are marked with *				

In conclusion, we could see that there are various categories of information that drivers would like to have when driving. Indeed, at various levels, they would also get different kinds of information. Thus, it shows that there are many kinds of information that drivers think are useful to their driving task. The literature review shows that there are a variety of studies that investigate drivers information needs. The studies were focused on many aspects, e.g. route diversion, commuters and dispatchers. Thus, the findings revealed in these studies were also varied. For example, Barfield et al., (1990) found that motorists population could not be regarded as homogenous. Streff & Wallace (1993) also found that even in different kinds of journey, the same drivers required different kinds of information. Moreover, evidence from Ng et al., (1995) shows that different types of drivers, e.g. commercial drivers and dispatchers have different information requirements. Berge et al., shows a typology of information requirements. This may suggest that there are a variety of types of information that drivers need for certain types of journey. As a conclusion, we could say that it is important to obtain information requirements directly from the population under study. This is because it is an important aspect of the systems design procedure as the population under study itself is not homogenous and has a lot of variability in terms of their information requirements. It cannot be assumed that findings from these studies would be applicable in Malaysia.

3.4.3. Discussion - Information Requirements

Table 3.3 summarises the nature of the key studies described above and the information needs found or mentioned to be important regarding driver information requirements. In comparing these studies, it is interesting to note that drivers required a variety of types of information. Thus, it is consistent with Haselkorn et al's (1989) conclusion that within the drivers population itself, the information needs of drivers were not homogeneous. With respect to the different types of journey, e.g. commuting vs. unfamiliar trips, there are similarities regarding the information that drivers need as indicated by Penttinen et al (1996). In their study, Penttinen et al., found that some information was required in both types of trip even though the purposes are different, e.g. going to and from work versus visit or leisure. This may suggest the importance of this information based upon drivers perception. The information may help them in making effective decisions'.

When deciding to divert to an alternative route, drivers also required more information related to the problem that they faced, e.g. delay time on original route or length of alternate route. Thus, the information systems designer should be able to provide a variety of types of information based upon drivers own criteria. In different types of journey, e.g. commuting vs. unfamiliar trips, drivers rated the importance of the 33 bits of information differently. This may suggest that in different journeys they want different information to assist them to decide whether to divert. Different types of journey might influence different needs of information. Indeed, different class of drivers, e.g. commuter, dispatcher or commercial also required different kind of information. It is perhaps related to the nature of their driving or work. For example, dispatchers would like information on the road and traffic information, whereas commercial drivers need information on navigation and route selection. Such results suggest the need for a variety of types of information. It also suggests that the information systems designers should be able to distinguish different needs of its end-users.

Table 3.3 - Summary of studies regarding driver information requirements

Authors	Nature of study	Information Needs
Streff & Wallace (1993)	Survey - information needed when deciding to divert in three types of driving in Michigan, U.S.	Came out with 33 bit important information, e.g. delay time on original route, length of alternate route, etc
Daniels & Levin (1976)	Survey - information provided by commercial radio in Chicago	Traffic condition Road condition
Penttinen & Louma (1996)	Telephone survey – information in two types of driving, e.g. work and unfamiliar trips in Finland	Similarity information in two types of driving, e.g. weather, fluency of traffic flows, routes and travel times
Mannering et al, (1995)	Survey - private travellers' preferences to ATIS in 11 states in U.S.	Alternate route, road condition, weather, regulatory and warning signs
Ng et al (1995)	Survey -commercial and dispatcher information needs in U.S.	Commercial driver - navigation and route selection Dispatcher - road & traffic information

In comparing the information requirement studies, it becomes apparent that authors have differed in how they defined information needs for different types of journey purposes. For instance, Mannering et al only focused upon the private travellers' preferences for ATIS systems. These private travellers in reality have different needs regarding information. Thus, they may define information needs differently according to the perception/experience and nature of the journey. Whereas, Daniels & Levin asked drivers regarding information given by commercial radio which could influence their decision. The different context may influence the needs for different kinds of information.

3.5. Methods of presenting information

Various methods have been developed to present traffic information to drivers. The methods include commercial radio, Radio Data System-Traffic Message Channel (RDS-TMC), Variable Message Signs (VMS), newspaper, television, in-vehicle and outside information systems. Despite the recent emergence of new product and services, the majority of road-users still receive their traffic information through radio and TV bulletins. 90 per cent of drivers rely on radio bulletins and 50 per cent on T.V. (Hayward et al., 1994). In addition, motorists' who desire information are able to listen to a radio in the car, or watch TV before leaving for work. Traffic information delivered by radio and TV broadcast reaches a large percentage of drivers, and clearly has the ability to affect overall traffic patterns during peak hours (e.g. Hayward et al, 1994; Streff & Wallace, 1993).

3.5.1. Radio broadcast

Most countries provide drivers with traffic information from radio broadcasts. This method often reaches many listeners. Information that has been presented includes messages about traffic situation, congestion, hazards and alternative route recommendations to the drivers. Many studies have shown that information presented by using commercial radio stations provide some assistance to drivers in order to make better decisions, e.g. the decision whether to divert to the alternative route recommended by the commercial radio.

Past research has shown that broadcast sources of information are by far the most commonly used traffic information sources (e.g. Spyridakis et al., 1991). Indeed, radio is the dominant sources of broadcast information and is used by more than 95 per cent of those who reported using such information. Streff and Wallace (1993) also found that trip type had no obvious effect on when traffic information was obtained. They found that more than 65 per cent of all respondents obtain information both before departing and during the trips. This suggests the capability of radio in conveying information to target audience in two settings, e.g. before departing and while travelling.

Research also shows that providing traffic reports before departing may affect drivers decision on several issues, e.g. driver may delay their departure time (e.g. Spyridakis et al. 1991 & Abkowtiz, 1981). This may imply the importance of radio traffic report in influencing driver's departure time. Whilst presenting radio traffic report during the trip may also influence a driver's decision whether or not to divert to alternate route. The findings of Khattak et al., (1993) and Emmerink et al., (1996) indicate that traffic reports affects drivers diversion decisions to alternate routes. This shows the importance and the performance of radio traffic report in influencing driver behaviour. Daniels et al., (1976) suggest several recommendations in which radio could be successful in influencing a driver's behaviour, e.g. that the radio should cover more routes, the reports should be more accurate and timely and more radio stations could provide traffic reports.

There are several advantages regarding the use of radio as the appropriate medium to convey traffic information to its end users. For example, some studies show that verbal presentation of information was more effective as compared to other modes of information presentation (e.g. Streeter et al., 1985). Verbal information was better in the driving task because it could substitute visual demands in the driving task.

Driving itself is an ideal situation for verbal presentation of information because it has heavy visual demands and low demand on the driver's hearing (Lieser, 1993). However, there are also problems regarding the use of the verbal mode of presenting information. One problem with verbal presentation is that it is transient and it must be repeated if the driver does not hear it the first time. Another problem is that speech cannot be scanned for relevant information as easily as visual displays and drivers must listen to the whole message.

Several other studies also found the negative side of the radio as the mode of presenting information. For example, Wallace & Streff (1993) found that some travellers assert that radio does not provide timely information. Motorists require timely information because it offers significant benefits for decision making. Although, there are significant advantages regarding the use of radio to present traffic information to motorists, we cannot leave out the disadvantages of the radio. Nevertheless, radio was regarded as the most commonly used medium of presenting traffic information.

3.5.2. RDS-TMC

New systems like RDS-TMC provides up-to-date congestion information with respect to a selected set of roads, as soon as new information becomes available at the traffic control centre or when the driver consults the system. Although, the system is thought to give certain benefits, e.g. providing very up-to-date congestion information, it also has its drawback, such as operating RDS-TMC applications is more attention demanding than listening to RDS-TMC messages (e.g. Katteler, 1995). Past study also revealed that programming the RDS-TMC applications may led to speed reductions (Katteler, 1995). This evidence suggests a considerable task load and, if the speed reduction is not sufficient to compensate for the increased task load, there will be effects on traffic safety. This shows that travellers must have good knowledge about operating the system before they use it. Thus, if the system were too difficult to operate, probably not many users would want to use it even if the system could assist them in many ways. According to Nielson (1993) there are two important aspects regarding the difficulty in operating RDS-TMC application in terms of attention demanding. Firstly, learnability, i.e. the length of time it takes to reach an 'expert level of performance'; and memorability, i.e. how quickly users can return to being an 'expert' after time away from using the system. Both are important for assessing the requirements for training with respect to a particular interface style. However, Katteler (1995) also revealed that listening to RDS-TMC messages were not considered more distracting than listening to traffic messages broadcast in a conventional way, e.g. commercial radio. The latter may sound comforting if one wants to present congestion information by speech but other research has shown that, as with different types of complex verbal tasks (Parkes, 1991), listening to conventional traffic information may affect driving safety (Akerboom, 1989).

Sometimes RDS-TMC may have two-combined modes, i.e. verbal and visual systems. Thus, drivers may have to glance to the RDS-TMC or listen to the messages which could affect their performance (e.g. Katteler, 1995). The two-combined mode, i.e. systems that present information on a map display and utilise speech messages with accompanying text display to convey information will certainly influence the users. For example, Verwey et al., (1996) found that drivers overload is likely to occur especially when drivers have to get the information derived from the map display and when the filter is programmed.

Furthermore, given the complexity of the speech messages, and the fact that these messages are system-paced, it may reduce driver performance. Studies on the effect of complex conversations showed that considerable mental workload reduces driving performance (e.g. Alm & Nilsson, 1994). Consequently, if RDS-TMC has an effect on driving safety, it is more likely that this will be caused by three types of driver-system interactions which are:

- extracting information from a map display
- extracting information from speech messages
- programming a filter on the RDS-TMC application

The above aspects could affect driving safety especially if the system has two combined modes, e.g. visual and verbal and it is difficult to operate/programme where the users must have good knowledge in order to use the systems (e.g. Verwey et al., 1996). In terms of the three level model of the driving task, control level behaviour (i.e. steering and speed control) is likely to be affected when drivers glance at the relatively complex RDS-TMC map display. Listening to complex speech messages will probably have limited effects on control tasks that are considered to be performed largely automatically. Manual system control is likely to affect course keeping due to the need to perform two concurrent manual tasks and the need to occasionally look at one's own actions.

The study by Verwey (1996) shows that although RDS-TMC has some significant advantages, e.g. providing real-time congestion messages, it also has some drawbacks. In the case of RDS-TMC systems, safety will probably be affected, not only by overload and distraction, but also by the route deviations caused by RDS-TMC messages. He went on to state that all RDS-TMC tasks affect safety, examining a map, listening to speech messages, as well as programming a filter. The importance of the Verwey study was the identification of needs toward more safe RDS-TMC systems. The findings clearly show that there is a need for further study to investigate the capability and performance of this system. Safety effects of high mental demands imposed by speech messages may be comparable to the effects of high visual demands of map reading.

There are other issues concerning the use of RDS-TMC as the appropriate mode of presenting traffic information. For example, the level of service needs to be resolved before travellers could use the information. If RDS-TMC systems do not cover certain areas, then the traveller might have a problem of not having information given to them. It is also related to the broadcaster factor because the use of RDS varies from country to country or even from one area to another. Thus, it could limit use of the RDS systems.

3.5.3. Variable Message Signs (VMS)

Another medium, which is quite new to local drivers, is the Variable Messages Signs (VMS). The definition of a VMS in the context of road application is ' A sign for the purpose of displaying one of a number of legends that may be changed or switched off as required'. The objective may be achieved by a number of different types of VMS from the basic mechanically operated flap on an advanced directional sign to a programmable dot matrix display. Variable messages sign systems contribute to road safety by reducing the frustration factor commonly observed when delays occur because drivers have no idea about the cause or duration of the delay or whether there is an alternative route available. In addition, credibility of the message displayed is a vital factor in determining a driver's behaviour but upgrading of communicating systems and improved incident detection should go a long way to ensuring that messages more accurately reflect the current condition on the highway.

The VMS certainly has several advantages. For instance, Emmerink et al., (1996) found that it influenced motorists route choice and diversion behaviour. In addition, it could be used in advising drivers regarding parking facilities (e.g. Polak et al., 1990). Several past studies reported the importance of VMS to motorists. Spyridakis et al., (1991) indicate that before drivers depart to their destination, they would use both commercial radio and television. However, during their trips, motorists were influenced by VMS. This may suggest the importance of VMS during the journey. In addition, motorists could have used both commercial radio and VMS in making certain decision, such as whether to divert to other route. Dudek et al., (1978) found that VMS messages were capable and effective in diverting freeway traffic to alternative route. This may imply that in determining driver's diversion decision, they should be given information by using VMS. Nevertheless, there are other factors such as experience and route network knowledge which could influence drivers decision whether or not to divert.

Variable message signs (VMS) have been used especially for parking guidance. It was intended to reduce the time spent by drivers when searching for parking space. Axhausen et al., (1994) estimated that search time could reach up to 40 per cent of total travel time for some groups of drivers. Polak et al., (1990) indicated that there were several ways VMS could influence drivers regarding the search for parking facilities. For instance, VMS could give information on location of parking facilities, direction and availability information. Although, this information could reduce travel time spent in searching for parking space and reduce anxiety, it also has some negative impact. The system is recognised by the majority of users but used by only a minority. In addition, the VMS would have greatest impact on drivers with a low level of local knowledge (e.g. Polak et al., 1990).

The method also has some limitations. For example, a driver's perception of a given message relevance to his needs will depend on the way in which he interprets his own needs. Richards et al., (1978) found that some drivers failed to see some or all of the messages. Thus, some drivers may not be influenced by the messages given to them by using VMS. Whilst this method has the advantage of reaching drivers locally and quickly, message sets limited to those which can be read by a driver at speed limit the amount of detail which can be carried. It also does not alert drivers further away or at home who could replan their whole route to avoid an area with congestion or an incident. Dudek et al., (1982) found that the use of VMS during incidents did not result in greater use of the diversion route than the amount of natural diversion that occurred without the signs. However, we could argue that this does not indicate the failure of the system as perhaps the messages came too late or some drivers apparently knew better alternative route. This may suggest that there were other factors that could affect traveller's diversion decision (e.g. Khattak et al., 1993). The above study clearly shows that VMS have advantages in assisting motorists. VMS is good in informing motorists regarding parking facilities and route diversion. However, it also carried some negative impact to drivers.

However, not many motorists would rely on the VMS advice. Thus, the system would not attract many potential users for receiving its messages. There were other factors that could influence drivers' decisions whether or not to follow the message given by VMS. For example, the message content will have general value which individual drivers must interpret. The subsequent driver decision will vary with their level of knowledge of the network and their ability accurately to determine the implications of the message for their own journey. Thus, the systems must be capable of presenting itself to the end users, e.g. messages should be easily seen and read, understood and memorised, interesting and useful (e.g. Caubert et al., 1994). Inaccurate or insufficient information could lead to conflicting actions, which could lead to accident.

3.5.4. In-vehicle systems

An in-car information system uses an in-car computer and some form of position-finding device to supply the driver with information as he progresses along his route. This system has the potential in displaying relevant information, e.g., from congestion information to wayfinding information while travelling to unfamiliar areas. There are a variety of types of in-vehicle systems, for instance:

- map displays possibly with current location and desired destination indicated;
- displays using simple arrows or voiced instructions
- autonomous navigation aids
- two-way communication systems

These systems get their information from various sources, e.g. satellites, road transmitters, or by autonomous means (i.e. dead reckoning and map matching technique, in which the direction of the vehicle and the distance travelled are measured by the vehicle). These new systems have several potential benefits. Van Winsum (1993) pointed out that the systems could offer benefits such as reduced travel time, help drivers avoid congested route etc. The two-way communication systems enable information from the vehicle to be passed to the central control. In turn, this allows:

- the guided vehicle to return information on their journey times, thus providing an internal database, or the enhancement of other centrally-held information,

- decisions on routes to be calculated centrally, thereby incorporating predictions for changes in network conditions.

The systems also provide a variety of types of traffic information including congestion and alternative routes. Thus, it is by far the most appropriate mode of presenting traffic information compared to other types of medium. These systems are also able to present information in two conditions, e.g. pre-trip and en-route to destination. This shows the capability of the new systems in assisting the traveller.

Ashby & Parkes (1993) indicate that the system could also give several types of route information to motorists i.e. route planning, route navigation and route guidance. For instance, route planning which is done before a trip might require information about route options, weather conditions, traffic patterns and the availability of service facilities. This shows that some of the information that drivers need has already been offered by the in-vehicle systems. Indeed, as suggested by OECD, drivers need comprehensive and accurate information on several aspects such as:

- the road network
- temporary changes (e.g. roadwork)
- traffic control
- vehicle flows/speeds/journey times
- incidents
- pollution
- emergency calls
- origins and destinations

The above list shows that in-vehicle databases contain numerous information that is important to drivers. No wonder the system is capable of assisting motorists as it has variety of types of information stored in its databases. There are many types of in-vehicle information systems, e.g. in-vehicle route guidance. These systems guide drivers to their destination with real-time procedural instruction (Ashby & Parkes, 1993). The efficiency of route guidance systems could reduce travel time, distance driven and help drivers avoid congested routes.

Despite development in in-vehicle systems, there are other aspects that need to be considered before the actual systems are used by the target audiences. As mentioned earlier, the systems could convey information in several modes, e.g. visual, verbal, arrow or map displays. The variety of mode of information presentation gives several benefits to drivers. For example, Streeter et al., (1985) concluded that the verbal mode of information presentation was better compared to other modes. However, different researchers concluded different findings. Liable (1989) found that the least amount of glancing was done at maps that were supported with verbal directions. This may imply that drivers preferred maps with verbal directions. In addition, Pauzie & Anadon (1993) found that a combination of verbal-visual display was optimal compared to verbal/speech messages. These different findings clearly suggest that more study is needed to investigate which mode is the most appropriate in presenting the information.

Research has been conducted aiming at comparing navigation systems with the use of conventional maps. Parkes (1989) compared a paper map display with a simple text display on a LCD screen. The text display showed left-right instructions and street names. He found that the average number of navigation errors in the map condition was 0.85 and in the text display condition was 0.45. This difference was significant. The implication from that was the text display was better compared to the map display.

Pauzie & Marin-Lamellet (1989) compared a memorised map with arrows displayed on a LCD screen. The average number of errors in the memorised map condition was 2.5, and in the arrow condition was 7. This significant difference implies that the memorised map is better than an arrow display on an LCD screen. Both studies show that different types of modes have different capabilities or advantages depending upon the nature of the task, e.g. navigation.

Besides having no specific answer regarding the appropriate mode to present the information, there is also some other serious limitations. For example, the impact of the systems on driving safety. Their introduction in cars may place more demands on drivers and interfere with safe operation of the vehicle. Indeed, Wierwille et al., (1993) show that in-vehicle systems do distract drivers' visual attention away from the road ahead. Rothe et al (1990) also found that the systems might demand more attention than driving and increases the risk of accident.

Apart from the ability to present the information to drivers, there are also many uncertainties concerning what kind of information should be given. Different investigators come out with different explanations. For example, in terms of presenting route guidance information, there are four media to present the information: text, symbols, speech and maps (Ashby & Parkes, 1993). There are advantages and disadvantages, in relation to safety and navigational performance, with each display method. Moreover, the type of information required is also linked to the display format. Liable (1989) compared the performance of three different methods of displaying in-vehicle information: electronic map alone, maps with auditory information, and map with written information. The findings clearly show that the least amount of glancing was at maps that were supported with verbal directions. Indeed, drivers were reported to prefer maps with verbal directions. Route recall was best for maps with text directions. He concludes that with respect to glance duration, maps presented with verbal directions were the safest way of presenting route guidance information. Verwey & Janssen (1988) in their study to compare the effectiveness of navigating by direction symbols, memorised map, and verbal directions show that subjects receiving verbal directions alone committed the fewest errors, followed by those given directional symbols. Drivers navigating by memorised maps committed most errors. The findings from Verwey & Janssen's study are consistent with Streeter et al (1985) who found that verbal directions were the most effective form of displaying route guidance information.

Nevertheless, there are several issues that need to be addressed. For example, Verwey & Janssen's study only examined navigational performance in terms of its effectiveness in guiding drivers to their destination. They did not examine the relative safety of using the three types of information display. Whereas, Liable's study investigated the performance of three different methods of displaying information with several measures, e.g. visual glance data, route recall performance and preferences. Consequently, different issues of study may prompt different findings.

Thus, the implication from the past studies clearly show that different kinds of system were used in examining performance and effectiveness. Different studies also investigated different kinds of mode to present the information. Therefore, no wonder that they arrive at different findings and conclusions. It is because of different settings, measures and equipment under study. They also did not investigate further the timing and the content of the information that should be presented to drivers. All of these three elements, i.e. what kind of information, when and how it should be presented are related to each other. They are also the basic questions which should be asked of the target audience before developing the systems. Some past studies clearly show some serious limitations regarding the use of the systems but this may be due to the nature of the systems being studied. Some studies use simulators or road track which do not represent the true nature of traffic in the real life situation. Nevertheless, all the studies provide guidelines to other investigators who are interested in examining the capability or performance of the in-vehicle information systems.

All the methods described appear to have some merit and drawbacks. Indeed, different researchers came out with different results regarding the suitable mode to present traffic information to drivers. This may hinder the development of appropriate information systems for drivers' use. The results also show that some drivers prefer to use in-vehicle systems, while others favour commercial radio as the main medium to present traffic information. This variety of drivers' responses reflects the need to investigate further. Thus, more studies are needed in order to develop the best method that is capable of presenting information to the potential target audience. Furthermore, there is a need to study Malaysian drivers' especially commuters regarding their response towards a suitable or appropriate mode or medium to present information that they require for different journey purposes. The information collected in this study could be used in developing some mechanisms/systems that are capable of presenting relevant information to its end users.

3.5.1. Discussion - Methods of presenting information

Table 3.4 summarises the different approaches taken by investigators in investigating appropriate methods to present traffic information to drivers. The table clearly shows different findings regarding the performance of the methods in presenting traffic information to drivers. It is interesting to point out that different kinds of method used in eliciting respondent's responses may prompt different kinds of findings. For example, Spyridakis et al used survey methods while Dudek et al employed road track trials where the context or nature of study may influence the results itself. Spyridakis only investigated drivers' experience/opinion whereas Dudek investigated the capability of VMS in assisting its target audiences.

With respect to the other mediums used, there are similarities in term of negative aspects of the systems. For example, RDS-TMC may give drivers overload (in term of attention and task) and distraction (if two combined modes were used). In-vehicle systems which have been currently developed by some car manufacturers also suffer some disadvantages similar to RDS-TMC, e.g. distraction (taking eyes of the road, e.g. Wierville et al, 1993).

These contradictory results regarding the appropriate methods to present the information that drivers need suggest the need for a method of obtaining potentially possible systems to present information. In addition, the future research should make several studies in terms of determining the best method to present information because there is no conclusive statement regarding the appropriate mode of presenting information.

It is apparent that different contexts and how they measure the variable, e.g. error when using the systems, may influence the results. For instance, some studies used glance behaviour and other used other terms. This may not be a proper measurement in terms of investigating the performance of the systems. Furthermore, researchers have not compared the methods of presenting information such as via commercial radio vs. RDS-TMC or in-vehicle systems.

Table 3.4 - Review of methods of presenting information

Methods	Authors	Positive findings	Negative findings
Commercial radio	Streff & Wallace (1993)	Dominant source - use it to plan routes, e.g. before and during trips	Information received irrelevant or late
	Daniels & Levin (1976)	Provide information on road/traffic condition - influenced departure time and route to take	N. A.
RDS-TMC	Katteler (1995)	Present information - timeliness	Difficult to operate
	Verwey (1996)	Give real time congestion etc.	Overload and distraction
VMS	Spyridakis et al (1991)	Present information during trips	N.A.
	Dudek et al (1978)	Diverting traffic to alternate route	Not many traffic will follow the advice
In-vehicle information systems	Streeter et al. (1985)	Present navigation information, e.g. verbal is better	Other mode such as maps, i.e. visual is less appropriate
	Pauzie & Anadon (1993)	Verbal-visual combination is best	Distracting and demand more attention

3.6. Timing for presenting the information

For systems to be acceptable to drivers, it must meet their expectations, based on their information requirements. The system should be designed to maintain or improve current levels of safety. In addition, it must not be damaging to safe driving as a result of a driver's distraction or lack of confidence. The appropriate timing of information that drivers require is critical to system acceptability and safety. If information is given too early, the driver is likely to forget the information whilst attending to other driving tasks. If the instruction is given too late, it will either cause the driver to brake suddenly or to maintain safe driving but miss the alternative route. Below are some of the literature concerned with the timing of information or instructions presented to drivers.

Fairclough et al (1991) showed that drivers reported a high temporal demand placed on them by the system as a result of instructions being given close to a junction. However, finding detailed information on values (in terms of time or distance) which resulted in appropriate and acceptable timing is more difficult. This study was only concerned with timing of route guidance information.

The distance to the junction or predicted time to the junction (i.e. based on current speed) are the most common criteria used to base the timing of route guidance instruction. The first is based on time to manoeuvre. Verwey et al (1993) states that if two manoeuvres are less than 10 seconds apart, the two instructions from the route guidance system should be given together, prior to the first manoeuvre. Based on this assumption, it is advisable to present the instruction more than 10 seconds prior to a manoeuvre. This equates to a distance of 140m at a speed of 50kph or 280m at a speed of 100 kilometre per hours (kph).

Kimura et al. (1994) specified that on 'surface roads' in Japan, a distance of 700m was needed to enable a lane change manoeuvre and a distance of 300m prior to a junction where the driver was required to turn across the flow of traffic (it is not clear if oncoming traffic was in motion or stationary). The study also states that vehicle speed; passing vehicles and number of traffic signals passed will effect appropriate timing of the instruction. However, there is no indication of how timing should be adjusted according to these varying conditions.

The studies, e.g. Verwey et al., (1993) and Kimura et al., (1994) clearly show the difference between two findings. Verwey et al., stated that it is better to present the instruction or messages more than 10 seconds before a manoeuvre or 140m and/or 280m compared to Kimura et al., who indicated that a distance of 700 m was appropriate to present the message to drivers. It also shows that the different nature of each study will result in different of findings. Verwey et al., used a simulator in determining the appropriate timing of presenting information whereas Kimura et al., conducted their study in natural setting, e.g. road. Perhaps, they came out with *different findings because of the nature of the experimental environment or the different culture of driving between Netherlands and Japan. Nevertheless, the studies provide some guidelines regarding the timing to present the information that drivers need.*

In a study by Tsai (1991), respondents indicated that for weather and traffic information to be useful for the trucking industry, it is needed to be transmitted at specific time intervals. Responses ranged from needing information every hour to every three hours for moderate weather conditions and every 10 to 30 minutes in severe or adverse weather conditions. Studies, by Barfield et al., and Tsai show different findings regarding the timing of certain types of information for different types of motorists. The implication from the above studies is that not only motorists have different information requirements but also have different specification regarding the timing to present the information that they required.

Spyridakis et al. (1991) found that most participants in their study required information before driving to their destination. Spyridakis colleagues, such as Wenger et al. (1989) and Barfield et al. (1989) also confirmed this finding. This may suggest the importance of giving information before departing. The information may influence drivers in several ways such as delaying departure time, thinking of changing mode of transportation or change to another route.

Mannering et al., (1995) also found that commercial drivers and dispatchers want certain types of information to be given further in advance. They conclude that conveying the information further in advance might help drivers in making effective decisions. For instance, they found that some travellers required the information on alternative route and road condition further in advance. It is clear that having such information far in advance can help them make their decisions with regard to work start/finish times and route choice. This may imply that by providing some information further in advance, i.e. early before departing, may assist travellers in making certain activities, e.g. delay departure time or route choices. Mannering et al., also found that some travellers would like to have weather information provided further ahead. This would suggest that weather affects route choices and that the route choice decision might be made close to the trip origin. Indeed, weather can have a severe impact on traffic during the congested time period and thus travellers prefer to have the information provided far in advance (i.e. closer to, if not at, their workplace). However, the difference between Mannering et al., and Tsai's studies was there was no objective specification regarding the timing for presenting the information to travellers. In Tsai's study, motorists would like to have the information at very specific time intervals, e.g. every 10 to 30 minutes for presenting the severe weather condition to drivers.

As mentioned earlier, in order for the systems to be accepted by its end-users, it needs to meet their requirements. Thus, the issue of timing of information to be given to motorists is particularly important to safety and efficiency of the system. For example, in terms of route guidance instruction, no specific information is available with regards to timing, probably because optimum timing depends on several variables: vehicle position on a multilane road, the vehicle speed, the positioning and density of surrounding traffic. Thus, we could imply that there is no standard requirements or specification regarding the appropriate timing for presenting information available yet to date. However, past studies provide some information on problems created by poor timing of instructions. One approach has been to relate the timing of an instruction to external cues or objects rather than specific time or distance intervals. For example, on the main roads (with signs), the next guidance instruction should be presented immediately upon the completion of the last manoeuvre (Schraagen, 1990). In addition, Schraagen also advises that the instruction should be given as soon as the drivers can see the related road sign. The guidance was also supported by Kishi & Suguira (1993). Based upon these studies, we could suggest that this approach to timing is applicable to roads where signs are located, providing the route guidance system has the knowledge in the placement of these signs. However, for roads without signs or where signs are only visible once the manoeuvre has been reached, timing needs to be based on other factors, probably independent of any external cues.

Ross et al., (1997) investigated the optimum timing of route guidance instruction with 15 subjects. They found that a prediction of optimum timing (in terms of distance) could be based on vehicle speed alone. The respondents in the study who mentioned that the timing was okay/appropriate was based upon subjective opinion. They conclude that in the early stages of developing a route guidance system, it will necessary to determine an algorithm to calculate at what point prior to a manoeuvre the driver requires the instruction. They suggested an algorithm for manoeuvres that meets the criteria - leaving the current route; not requiring a lane change; not at the end of a road; without a slip road (i.e. sudden turn); for speeds between 18 kph and 101 kph. These imply that vehicle speed could be use as the cue, e.g. timing to present the instructions. In addition, different criteria of manoeuvre would require different timing to present the information. Thus, we could suggest that different situations would require different sets or specification for timing of presenting the instruction.

However, Ross et al., did not compare the effectiveness of different modes of instruction (i.e. visual or verbal). It is assumed that different modes of instruction would require different timing of presenting the information. Indeed, Ross et al's., study was the first to systematically investigate the optimum timing of route guidance instructions which gave several indications regarding the importance of investigating the appropriate timing of information. Their study also suffers several limitations. For example, only one particular type of junction was used. Thus, the findings should only be applied to this type of manoeuvre. Nevertheless, the importance of their study was regarding the use of 'stack instructions' (i.e. give instructions for two subsequent manoeuvre in a single message). According to the rule: when the distance between two subsequent manoeuvres is less than the minimum preferred distance for that speed, the instruction should be stacked. Thus, this suggests that at one situation, the instructions should be given in such a way that the traveller could know the objective of their actions.

Theoretically, we could say that the information must be given to drivers early enough for them to be able to act on it, but not so early that it might be forgotten before it becomes relevant. Thus, if one has forgotten the messages, the system may repeat it. However, this may annoy drivers, and encourage them to take their eyes off the road, which interferes with the acquisition of subsequent messages. On the other hand, if the information is given too early, road conditions relating to an event may have changed by the time the driver reaches them. The study by Graham & Mitchell (1997) shows that the optimal timing of messages will vary according to their information content. They concluded that a message that is purely informative in nature (i.e. 'Accident 5 miles ahead') will not need to be retained in full by drivers, but will allow them to expect traffic changes. However, they also found that when information is given requiring definite actions as a specific point (e.g. '30 mile speed limit - 1 mile ahead'), then this must be provided close enough to the event for the driver to act accordingly. Their study clearly suggested that types of information, (i.e. content of information - whether it is informative or need immediate action) may require different standard of timeliness to present the information.

In addition, as mentioned by Ben-Akiva et al., (1991) there are three types of temporal nature of information, e.g. historical, current and predictive information, which could influence the timing to present the information to drivers. Thus, based upon Graham & Mitchell and Ben-Akiva studies, it is suggested that other factors or relationship exist between the timing of information presentation and the content of information that drivers require.

One could argue that the three basic questions, e.g. what information do drivers require? ; When do they need the information (i.e. refers to timing of information) and how the information is to be presented? are related to each other. In other words, one issue will influence the other two issues. No wonder the findings of Graham & Mitchell study clearly shows that the timing of information was influenced by the content of information. They also found that the ability of drivers to recall messages was also affected by the length and type of messages, and the length of retention period. Nevertheless, the Graham & Mitchell study also suffers some drawbacks. For example, the information presented to drivers, although representative of the information which was commonly given to drivers in real life situation, was of no strategic value in terms of current road environment, and lacked the contextual aspect to be expected in a real system. However, the study shows some interesting findings, which may enhance the knowledge regarding the appropriate timing to present information or messages to drivers.

In the case of route guidance systems which inform drivers regarding the distance remaining prior to the next manoeuvre, there are three different formats of distance representation within drivers' cognitive maps of the environment (e.g. Downs & Stea, 1977). These can be interpreted as modes of presenting distance to turn information to drivers. For instance:

- Absolute (e.g. 500 metres, 3 miles)
- Relative (e.g. 'half way there')
- Costs (e.g. time - 'soon')

The above examples show the different modes to present information to drivers especially regarding turn messages. Thus, it was suggested that the above timing could be used to present relevant information to drivers. However, one may question the reliability of the timing or mode in informing drivers regarding the distance remaining prior to next manoeuvre. It is because there may be other factors, which could influence traffic conditions when the system is conveying the messages to drivers. For example, as traffic density increases and the road situation becomes more complex, the workload demands on the driver increase. Thus, it may interfere with their task, e.g. observing traffic, the timing of the messages and listening to the message that enables them to decide.

In addition, Kimura et al., (1997) also investigate the timing to present lane change information before the driver was able to select the proper lane. In their study, they found that the distance required for lane change is related to the number of lane changes, the vehicle speed, the number of passing vehicles, and the number of signals passed. It was defined as about 700 metres in order for drivers to execute a lane change without anxiety. Their result suggested that route guidance systems should present messages (e.g. lane change) to drivers approximately 700 metres before they actually change lane. The importance of Kimura et al study was the identification of different timing of messages in different types of situations, e.g. lane changing, intersections or junctions. Indeed, their study clearly revealed that the systems, e.g. route guidance should be able to distinguish between the various needs for information and timing of that information to drivers.

In conclusion, we could say that the various studies revealed different kinds of timing to present information that drivers required. For instance, some researchers use measures such as before or during the journey, while others use measurements such as 10 seconds prior to manoeuvre. This may suggest different criteria were used in examining the possible timing to present traffic information to drivers. However, these studies concentrated upon the respondents subjective opinions regarding the possible timing that drivers required the information, e.g., before they drive to their destination, during their journey to the destination or in both situations, e.g. before and during the journey.

3.6.1. Discussion - Timing of presenting the information

Table 3.5 summarises the nature of the key studies described above and the timing of presenting information that drivers required. It is interesting to note that different studies would suggest different kinds of timing to present the appropriate traffic information to drivers. For example, Kimura et al in their experiments indicate that in order to give information regarding lane change manoeuvres, the in-car systems should be able to convey at information 700 metres before the driver actually did the task. Whereas, in Barfield or Spyridakis studies, they asked drivers regarding the timing itself, e.g. early morning (before departure) and late afternoon. Thus, we could suggest that different kinds of methods employed might result in different kinds of timing.

In addition, different kinds of information may also require different sets of timing to present that information. For instance, Tsai argued that drivers need weather information in three conditions, e.g. severe weather information should be presented every 10 - 30 minutes. Thus, one may suggest the importance of these types of information to drivers. Others such as Ross indicate that in order to give route guidance information, speed alone can be the best element in determining the timing of route guidance information.

The tables also described the different sets of information content, e.g. information that needs immediate action should be presented close enough to event, whereas if the information is just to inform, the timing would be different. Such results clearly show at different timing should apply even when the information itself differed in terms of contents.

In comparing the various timing to present information, it is apparent that authors differed in several ways, e.g. how they defined the term 'traffic information' and the context in which the information should be given. Some of them are using experimental methods in order to come out with objective measures such as 700 metres before the event or others. Whereas others mentioned drivers' own experience or opinions which could be classified as subjective measure such as further in advance or before departure. This certainly makes the task to present the information difficult because there is no clear-cut guidance regarding the appropriate timing to present the information.

Several authors confined their studies to only route guidance information while others concentrated on other types of information. Based upon their studies, it is clear that drivers will need different sets of timing to present the different information. The above studies also show the difficulties of arriving at a consensus regarding the appropriate timing to present the information. Indeed, more studies should be done concurrently with the method to use and the variety of information to be presented. In addition, it should be interesting to find that different modes would require different sets of timing to present different kinds of information to its target end-users.

Table 3.5 - Summary of studies regarding timing of presenting information

Authors	**Nature of study**	**Timing of information**
Verwey et al (1993)	Experiment-instructions of route guidance	2 manoeuvres should be given together - 10 seconds prior to a manoeuvre
Barfield et al (1991)	Survey-traffic information presenting	Early morning and late afternoon
Tsai (1991)	Survey- weather & traffic information	Different categories of weather prompted different timing, e.g. severe - 10 to 30 minutes
Mannering et al (1995)	Survey-traffic information, e.g. road condition and alternate route	Both information should be given further in advance - as warning or influence their decision
Ross et al (1997)	Experiment-leaving current route	Timing could be based upon speed, e.g. to present information -
Graham & Mitchell (1997)	Experiment-information require immediate action	Should be given close enough to the event
Kimura et al (1997)	Lane change messages	700 metre before actually did it

3.7. Navigation Studies

Car driving can be subdivided in three behaviour levels: navigation, manoeuvring and control (e.g. McRuer et al., 1977). Navigation itself requires skill in order to reach the final destination. The term navigation and wayfinding are often used synonymously and they can both represent spatial problem solving activities (e.g. Kitchin, 1994).

Navigation is a broader term that refers to both the strategic routes planning level of the spatial problem solving task and wayfinding. Limited knowledge regarding information people need while finding their way and planning their route or trip need to be examined. In addition, strategies used by people in order to guide them to unfamiliar destinations also need to be investigated. This information could benefit not only the motorists but also the responsible agencies, in order to design some kind of systems which aim at helping motorists while making unfamiliar trips.

The main purpose for driving, in most cases, is to safely, conveniently and independently gets from one point to another. Difficulty in finding the intended destination diminishes the functionality of this form of transportation and threatens the mobility of its users. FHA (1992) reveals that navigation (e.g. wayfinding) problems could have severe implications considering that the car is the most common means of personal mobility. In addition, errors in wayfinding may have implications for road safety.

It is known that driving is not a particularly demanding task in most instances (Näätänen & Summala, 1976). Nevertheless, Wierwille et al. (1988) found that navigating a car on unfamiliar roads could be very demanding on a driver's attentional resources. Mourant et al. (1970) also found that the visual demand of roadway information is higher on unfamiliar routes. In addition, wayfinding problems could lead to wasted time and fuel, and contribute to traffic congestion. Navigational waste is considered to be significant problem by transport researchers. For instance, Bovy & Stern (1990) state that navigational waste or excess travel "... is the difference between the amount of travel that actually occurs on the network and the amount that would occur if every vehicle trip followed the desired optimum route". Wayfinding problems are also likely to be stressful and embarrassing to drivers. Little is known about this kind of study in

Malaysia, especially the method that drivers use when they travel to unfamiliar areas/ destination. Therefore, it is important to review what is known about how people find their way in cars. The thesis is only interested in how drivers plan their trips and find their way while driving to unfamiliar destinations. For the purpose of this research, wayfinding and route planning will refer to the strategies used by the drivers when making unfamiliar trips. Limited knowledge and studies regarding drivers' wayfinding strategies in Malaysia, especially in the major cities require more studies to be conducted concerning drivers performance when making navigational activities.

3.7.1. Driver Wayfinding and Route Planning Research

Little research has been done to identify the strategies that drivers use to plan their routes and find their way in unfamiliar destinations. However, some of the studies show that road maps appear to be the most common form of navigational assistance for drivers. Sheppard and Adams (1971) found that 95% of drivers in their survey would use a map to plan their route and forty-four per cent of respondents said they would use a map during the trip if they were driving alone. While, Astley (1969) found that almost half of the respondents relied on written notes to navigate. The majority of these notes were taken from maps. However, the relevance of the findings to today's traffic environment and Malaysia in particular may be questionable because both studies were conducted over 25 years ago. In addition, the strategies used by the respondents in both the Sheppard & Adams and the Astley studies may not have represented the actual navigation strategies. Nevertheless, Mark and McGranaghan (1988) found that 87% of respondents (N= 48) would refer to a map when travelling in an unfamiliar city. They also concluded that maps tended to be used more for planning than for in-transit navigation. Thus, map usage may be the dominant strategy used by drivers.

Streff and Wallace (1993) investigated drivers' preferences for travel information. They found that respondents indicated a clear preference for directions from maps supported with written information and/or verbal instructions from a passenger when driving in an unfamiliar area. They also found that the majority (78%) of respondents found maps easy to use. However, one of the disadvantages of the Streff & Wallace study was that the survey only skimmed the surface of route navigation. It is because they only asked about wayfinding in familiar and unfamiliar areas. These terms are imprecise considering that areas could be urban, suburban or rural and this, as well as the road type (i.e., motorway or country lane), may have an important influence on the strategies people employ. Different situations may bring different strategies that drivers would employ. Similarly, strategies of drivers in America and the U.K. may be different to those in Malaysia. Motorists in Malaysia may adopt different strategies for wayfinding because the urban road environment here is different compared to the U.K. and most of Europe and North America.

Although, previous studies conclude the significance of paper maps in assisting drivers, it does not necessarily mean that they are the best tool for meeting human wayfinding requirements (Petchnik, 1989). Other studies have acknowledged that map reading is a difficult cognitive task, which involves learned rules, and have estimated that 64% of the general population experience difficulties when reading maps (Streeter & Vitello, 1986). However, Wallace and Streff (1993) found that more than 75% of respondents indicated that maps were very or somewhat easy to use compared to less than ten per cent who answered maps were either somewhat or very difficult to use. Thus, we could see that the different investigators come out with different findings. However, one need to look at the nature of both studies. For instance, Streeter & Vitello did a study in using the maps itself while navigating in unfamiliar environment whereas Wallace & Streff were only asking respondents to comment about the usefulness of map usage in selecting routes.

Reading a map when driving has predictability been found to be even more difficult, and is inevitably associated with high task workload and large percentage of time spent with the eyes off the road (Fairclough & Parkes, 1990). Indeed, drivers are well aware of the possible consequences of using a map when driving. Smith (1978) found that drivers rated reading a map while driving to be the most dangerous activity. With such comments and findings, it is not surprising that many drivers use written notes or sketches for a journey to unfamiliar destinations (Parkes & Martell, 1990). However, even notes and sketches are fundamentally flawed, since information can be inaccurate or misread by the driver, and is of little practical use if a navigational mistake is made (Wickens, 1992).

In another study, Gordon and Wood (1970) examined informational aspects of wayfinding. In this study, they had two groups of 10 young American drivers travelled to two different unfamiliar destinations (e.g., an address in another town) using whatever information they could obtained. A control group of five drivers were given directions from an experimenter. The result shows that the unfamiliar drivers drove less efficient routes in terms of time and distance. Most of their time was spent lost in the vicinity of their destination. Almost all of them would travel to the local area then consult a service station attendant for specific directions. They concluded that local wayfinding is difficult because the driver must obtain detailed information that is not available on large-scale maps. This study clearly demonstrated the disadvantages of paper maps in assisting driver navigational activities.

Navigational decisions are made on the basis of information from the outside view, the navigational aid, and the drivers' mental representation of the environment (cognitive map). The use of the drivers' internal model of an area, commonly referred to as cognitive maps as the main tool to elicit the information types required for route following has been used to investigate the content of information while navigating to unfamiliar destinations. Obata et al, (1994) in their study asked their subjects to either sketch a map or write verbal directions indicating how to reach their destination from their house. The information was categorised using the five elements of a cognitive map proposed by Lynch (1960).

Lynch (1960) conducted several studies to determine the aspects of a large-scale environment people contained within their cognitive maps. He found that people seem to categorise their environment into five types of element such as (i) *Paths* which is defined as the channels along which people move, e.g. streets, footpaths, (ii) *Nodes* is defined as points where several paths meet, e.g. junctions, (iii) *Landmarks* is defined as external reference points which are easily observable from a distance, e.g. towers, monuments, certain buildings and bridges. (iv) *Districts* is defined as the medium-to-large sections of an environment, which the observer mentally enters "inside of", and are easily recognised as having some common, identifying character, e.g. the city centre, University campus, etc. and (v) *Edges* is defined as linear elements that serve as boundaries between districts or other areas, for example rivers, walls, fences etc. Based on Lynch categorisation, it is clear that drivers used these five types of elements in planning and finding their way while travelling to unfamiliar surroundings.

In another study, Obata, Daimon & Kawashima (1993) conducted a verbal protocol analysis on the navigational information needs in Japan (N = 5). Their participants were unfamiliar with the route. Obata et al., found that drivers frequently requested information about landmarks to identify their next decisions point (e.g., traffic signals, shops and signs) and the distance to that point. They also found that landmarks was one of the elements used by drivers while navigate. However, the generalisability of these finding is questionable because of the small and non-representative sample studied.

In another Obata et al (1994) study with 44 subjects, they found that the majority of information noted by subjects were related to the landmark, node and path categories based upon Lynch categorisation (1960) but little information was noted regarding districts or edges. This was probably due to the nature of the navigation task given by Obata et al., to their subjects, which required drivers to focus on the regions either side of and along the road, and less on the global scene. The subjects in Obata et al (1994) study were asked either to sketch a map or write verbal directions on how to get to their destination. They found that more information was noted in the map sketches than in the written directions. Perhaps, subjects found it easier to explain the routes with a map than with step-by-step directions. Nevertheless, the information in the map sketches that was provided by subjects had many distortions. Thus, the result suggests that a driver information system (e.g. route guidance system) need not present accurate 'map-like' knowledge to drivers, and instead may present deformed 'network knowledge' (Freundschuh, 1991).

Alm (1990) investigated the aspects or cues from the environment used by drivers during navigation. He conducted two kinds of studies, e.g. in the first study, 19 subjects were asked to provide written directions on how to reach three destinations within the Swedish city of Linkoping. Meanwhile, in the second study, 38 subjects were asked to write verbal descriptions and also to sketch maps on how to find three different destinations in the same city. The classification outlined by Lynch (1960) was used to represent the study result. Alm found that all subjects predominately used paths, nodes and landmarks to describe routes. Nevertheless, there were differences between Alm and Obata's et al studies. Alm studies revealed that traffic lights to be the most popular landmarks, followed by traffic and orientation signs, shops, petrol stations and bridges. In addition, Alm also broke down the categories of landmarks into several general classes rather than the individual landmarks as reported by Obata et al.

In Schraagen (1990) study, he found that the source of information was more of traditional paper mappings rather than cognitive mappings. The aims of his study were to gain an insight into how drivers navigate under normal conditions and what difficulties they encounter. 24 subjects were asked to drive on four prescribed routes in the Dutch city of Amersfoort. The subjects were instructed to give a verbal protocol explaining what types of information they were looking for during the journeys. Schraagen used Kuiper's theory of spatial knowledge (Kuiper, 1978) rather than Lynch classification in categorising the navigation information verbalised by the subjects. The analysis revealed that most references were made to street names, followed by topological information, e.g. road characteristics/types, counting streets, junction angles, landmarks, road signs and finally metric information, e.g. compass directions, distances.

The results from Schraagen (1990) study stressed that it is quite common to find out that subjects made an extensive use of street names, since a positive relationship was found between reliance on street names for wayfinding and increased navigational errors. However, it must be noted that such results were based on the study of traditional navigational strategies, whereby street names may have been used as a primary information source and not purely for confirmation purposes. Indeed, Davis (1989) indicates that street names signs can be poorly visible, inaccurate and misleading, or perhaps not even present. Thus, it can be expected that increased navigational errors arise from the use of such a strategy.

Human refers to internalised representation of environmental objects in order to know their position in space and to decide in which direction to move to arrive at a particular location. These representations are structurally interlinked and stored in memory as a cognitive map. It enables us to relate our position to those of other objects even if we are in open environments. Drivers refer to their cognitive maps when they plan and follow routes. Daimon et al (1997) found information that a driver needs to navigate in an unfamiliar area varies. For example, subjects requested and relied primarily on information about landmarks, paths, and nodes to navigate to their destination. Indeed, the most frequently used landmark was the traffic signal and the most frequently used path was the distance to the next turning point. In addition, they also found that subject were only interested in obtaining information about one specific condition. Subjects also do not want to receive too much information at any one time. Thus, it may be suggested that too much information may affect a driver's ability to navigate in unfamiliar destinations.

Daimon et al., finding was consistent in terms of various types of information used by drivers while navigating in unfamiliar destinations. For example, Alm and Obata also found extensive use of landmarks (e.g. traffic signal) in assisting drivers to navigate. Indeed, different kinds of approaches used in investigating information drivers need to navigate resulted in similar evidence in which it could suggest the similarity between drivers in all those studies regarding the importance landmark in helping them while navigating. Based upon the literature, it can be said that there is only a superficial knowledge about what people use to plan their routes and find their way while driving. In addition, consensus from past research indicates that people mainly use maps and take notes in preparing to drive to an unfamiliar destination. While driving alone, they follow their notes or memory of a map. Previous research did not address many of the issues, which are relevant to this thesis. For instance, what other strategies and information that people need to find their way and plan their routes.

3.7.2. Source of Navigational Information

Navigation consists of two main important elements, e.g. route planning and wayfinding. Many researchers have given different definitions concerning wayfinding or navigation. These definitions can be associated with the abilities or procedures. For example, wayfinding can be defined as the ability to learn and memorising routes through an environment (Blades, 1991). In addition, wayfinding also refers to how well people are able to find their way to a particular destination without delay or undue delay (Peponis, et al, 1990). Indeed, it is also describes how spatial knowledge is acquired, the ability people have to find their way, or the process they use to find their way. The thesis is interested in how people find their way and planning their route in unfamiliar trips. This include identifying the source of navigational information, i.e. methods that driver would use when they actually make route planning and finding their way in unfamiliar environments.

Several models have been developed in determining how people acquire environmental information through wayfinding or navigation. For example, Kuipers' model of spatial learning (1978) proposed that as people move through space they observe *views* and perform *actions*. The view can be described as what is seen from a specific orientation at a specific place. Whilst an action is the movement that changes a particular view. For example, a learned route involves a proceduralised set of these view-action pairs. When people become more familiar with the environment, their knowledge progresses from declarative and procedural route knowledge to a more topological and metrical representation of space (Kuipers, 1978). However, Thorndyke & Hayes-Roth (1982) suggested that procedural knowledge or a route contain more information than these view-action pairs. There are an additional information such as distance travelled along route segments, the angle of turns, and features of the terrain along the route. Thorndyke & Hayes-Roth suggestions show that Kuipers theory has a several limitations. For instance, the process described by the model is different from how people actually learn about and find their way within an environment (Golledge, 1992).

Wayfinding or navigation can also be said as a spatial problem solving activity. It depends on decision-making, decision execution and information processing. Drivers must make a decision at each point along a route where they are faced with more than one option. For example, at a junction, a driver has several possible manoeuvres to choose from, they could: continue straight on, turn left or turn right. Information for these decisions is obtained from the traveller's spatial representation of the environment. Passini (1984) indicates that some of this environmental information may be perceived directly in the setting, some retrieved from previous experience or inferred from a combination of existing information.

As mentioned earlier, the task of driving a car can be divided into three elements: navigation, manoeuvring and control (McRuer et al., 1977). The navigation activity can be said as a spatial problem solving (Alm, 1993). The purpose of this task is to get from a starting point to a particular destination. This involves navigators' decisions at each node or intersection in the roadway network (Antin, 1993). These decisions can be planned in advance or made while driving. Drivers need a certain information to make these navigation decisions. For example, drivers need to know which direction to drive, when to turn, and which way to turn. They also need to know how far they are from their destination, when they have arrived, and their progress. This requires the recall of a cognitive representation of the desired route or the extraction of this information from a printed map, road environment, human navigator, road signs, written instructions or electronic navigation system (Schlegel, 1993).

Indeed, there are variety types and sources of information that could support travellers' navigational decisions. For instance, Schraagen (1993) has identified five categories of environmental information that drivers use to find their way: street names, road signs, landmarks, topological knowledge (e.g., road characteristics, road types, counting streets), and metric knowledge (e.g., distance, compass orientations, angles). Nevertheless, one of the environmental sources of information that could support travellers' navigational decisions is spatial knowledge. It is acquired through our experience within an environment. This knowledge is a two-dimensional mental map like representation of space that includes measures such as angles and distance. Other knowledge such as route learning usually involves the grouping of route segments. It could make it easier to learn and organise the large amount of information that make up a route. It also helps in the recalling of the route. In addition to spatial knowledge, both declarative and procedural knowledge is also required for navigation tasks, e.g. wayfinding (Gale et al., 1990). For example, declarative knowledge is the ability to describe features of a route to others, while procedural knowledge is the ability to follow the route. Gale et al., (1990) indicate that people may know certain facts about a route and not have the ability to negotiate that route.

Kuipers (1978) proposed that spatial knowledge grows from an initial landmark and route type knowledge to the more detailed configurational knowledge. However, other argues that a driver can learn the configuration of a space from a map or similar representation without having physically travelled through space (e.g. Thorndyk & Hayes-Roth, 1982). Indeed, Golledge (1992) also pointed out that man may also travel through an environment by reading a book, listening to a verbal description, or viewing image records such as slides, tapes or television transmission. Nevertheless, most environmental information is acquired by travelling through it (e.g. Golledge, 1992). This knowledge tends to become more accurate with the increasing experience of the environment (Thorndyke & Hayes-Roth, 1982).

Another aspect of spatial knowledge is cognitive map. According to Kitchen (1994), cognitive map is a source of information concerning spatial relations and environmental attributive data which allows one to operate within the environmental and process environmental and geographical data. Cognitive maps are developed based on our experience with an environment (e.g. through navigational experience, maps and verbal directions) and contain a complex array of spatial information such as location, distance and density. Cognitive maps enable us to relate our position to those of other objects even if we are in an open environment. Thus, a cognitive map permits 'solving problem in space' such as self-orientation, estimating distances to objects. Drivers refer to their cognitive maps when they plan and follow route.

One of the features of cognitive maps is a spatial schema. This spatial schemata provides us with a general understanding of the layout and pattern of typical environments (e.g. a city) and contribute to effective wayfinding in these environment (Blades, 1991). According to Beck & Wood (1976), the more one travels to other cities, the more he or she acquires general knowledge of the way the cities are organised. In addition, Devlin & Bernstein (1995) pointed out that new information, which is encountered, is added to the existing schema in the cognitive map.

As mentioned in Schraagen (1993), drivers also use landmarks as one of their sources of navigational activities. Lynch (1960) indicated that landmarks are point references, while Golledge (1992) defined it as known places that provide information. It can be used to 'anchor directions or to act as foci for wayfinding of the regionalizing of information' (Golledge, 1992). Features like buildings, trees, junctions and parks can be landmarks. The characteristics of landmarks are important because they influence their ease of recognition. Among others, these characteristics include location, name or identity, colour, shape and size (Golledge, 1992). In Schraagen study (1992), a majority of drivers preferred to have clear landmarks when receiving directions. In addition, other studies such as Akamatsu et al. (1994), Alm (1990) and Burnett et al. (1994) have identified the importance of landmark information for driver wayfinding.

Apart from environmental sources of navigational information, other sources of information could be categorised as being from inside or outside the vehicle. For example, map information would come from inside the vehicle and road sign information would appear as an outside of the vehicle. Nevertheless, these categories are not exclusive and some information can be available in both places. Compass orientation information could be displayed by compass inside the vehicle or from clues in the environment like the position of the sun or the orientation of features like building. In addition, the rate of movement information could also come from an in-vehicle source like a speedometer or from the speed at which outside objects move through one's visual field.

Roadside signs also can provide drivers with all the information which is necessary for navigation. Route guidance signs can be distinguished from other types of signs by their size, shape, placement and colour (Lajunen, Hakkarainen & Summala, 1996). In addition, signs also provide spatial information about location, path segments (road and street names), direction, distance, layout (e.g., an overview of a complex junction), and the interrelations between places (e.g., ordered list of towns or landmarks).

Second source of navigation information is a map. Maps could provide people with many different types of environmental information. Maps also give a configuration representation of the road network and the different categories of roads. Furthermore, maps also could display distances, directions and landmarks. For example, McCann (1982) identified 18 separate map tasks ranging from orientation to memorisation. However, one of the major drawbacks of road maps is they tend to contain too much information for a single journey. Consequently, it is difficult to deduce information such as location and orientation quickly from the clutter of a map (Antin, 1993). In addition, their size and design may also make them difficult to handle and dangerous to use while driving. Nevertheless, the advantages of map are that they allow for error recovery and provide information about other possible destinations (Mark & McGranaghan, 1988). For example, if drivers go off their intended route, maps can help them to find their way back on track.

Another common source of in-vehicle information for navigation is route notes. Route notes can be derived from maps or information provided by a person who is familiar with the route. Route notes can also come from a computer route planning program (e.g., AutoRoute) or a motoring organisation. These notes, which are often customised by individual traveller, can provide spatial information for routes (e.g., a list of decision points and landmarks) and configuration information (e.g., sketch maps of junctions). The advantage of notes is they operationalise the step-by-step decision making that is needed to negotiate a route. The problem with notes is that they are useless if a driver goes off the planned route.

Passenger instruction also is one of the common sources of navigation information. For instance, In Streff & Wallace (1993) study, they found that subjects rated the passenger instruction as the preferred method for wayfinding. Passengers could provide information, which is necessary for drivers to make wayfinding decisions or even make decisions for the driver. In addition, passenger may obtain the same information as the driver (e.g., from a cognitive map, road atlas, route notes, etc) and can convey this information verbally or by pointing them out to the drivers. The advantage of having a passenger navigating is that drivers would have fewer tasks to perform. However, problems may arise in communicating between driver and navigator. For example, the passenger may not supply the information that is needed, or at the time it is needed.

Another source of wayfinding information is the use of in-vehicle information systems. The in-vehicle systems can be classified as drivers information system and route guidance systems. These systems provide a wide range of navigation relevant information that could help drivers. For example, route guidance is one of the categories of route information that can be provided by the in-vehicle information systems. Ashby & Parkes (1993) divided route information into three categories such as route planning, route navigation and route guidance. Route planning, which is done before a trip begins, might require information about route options, weather conditions, traffic patterns, and the availability of service facilities. With route navigation, drivers are given details about the road network and are left in control of route decisions. Meanwhile route guidance is a real-time in-transit route information that guides drivers with a set of procedural instructions through each manoeuvre to a destination. At a minimum, route guidance systems can provide drivers with information on the distance and direction to a specified destination (Antin, 1993). These systems tend to guide manoeuvres with direction arrows and supplementary digitised speech instructions.

Past studies show that there were numerous sources of navigational information that drivers could use while travelling to unfamiliar environments. For instance, maps, landmarks and others. Some drivers may use both sources while others tended to use only one strategy. Nevertheless, past studies also have shown that drivers could use various information which could help them while driving to unfamiliar situations. In addition, variety of sources of navigation information could also influence the strategies that drivers used when travelling to unfamiliar destinations. It also affected peoples' abilities to find their way and their performance while making unfamiliar trips. These strategies also could be applied to the route planning strategies for unfamiliar destination. In this thesis, strategies that drivers use when making an unfamiliar trips were examined in an attempt to investigate Malaysian drivers in general, concerning their strategies used in several unfamiliar destinations.

3.7.3. Discussion - Navigation strategies

Table 3.6 listed the studies that concentrated upon the variety of navigational strategies. In comparing these studies, it is suggested that different kinds of strategies were used in order to achieve driver's navigational goal. For example, Sheppard & Adams clearly show the use of maps in helping drivers to plan their route. In addition, Streff & Wallace findings also show some evidence on the significant of maps as the source of travel information by drivers. Indeed, drivers in their study also preferred maps to be supplemented with written information or verbal directions. However, it is apparent that such a source may not be as ideal as claimed. The use of maps can be criticised. It is well documented that people experience difficulties in extracting relevant information from maps (Streeter & Vitello, 1986).

Table 3.6 - Review of studies on navigational strategies

Authors	Nature of study	Strategies employed
Shepperd & Adams (1970)	Plan a route to unfamiliar destination	Maps - use widely by respondents
Streff & Wallace (1993)	Survey - preferences for travel information	Maps supported with written information/verbal instruction from passenger
Gordon & Wood (1970)	Experiment - asking drivers to go unfamiliar destination with whatever information they could get	Most respondents would asked someone for route direction, e.g. at petrol station or passers-by
Obata et al (1994)	Experiment - paper/pen Asking respondents about content of information navigate to unfamiliar destination	Sketch a map or verbal direction in order to reach A from B
Alm (1990)	Route descriptions in Sweden-paper and pen test	Use landmark - traffic lights, signs, petrol station, e.g. cues from environment

Furthermore, investigators have used different kinds of methods to investigate the types of strategies drivers used in navigation. The different set of strategies may resulted from the different kinds of methods used in which they were investigated. For instance, people differ considerably in their ability to provide directions and the context within the study itself is not being generated in the context of the driving task, which may hamper the generalising of findings to the real world.

Such contradictory results suggest the need for a method of obtaining potentially useful or appropriate strategies; a method which is applicable to all types of condition or context. In addressing this concern, it would be important to establish and investigate thoroughly the attribute of strategy, which will influence the ease with which it can be processed and remembered.

The final point, in comparing the variety of types of strategies that drivers used, is the different terms of measuring how drivers currently navigate to unfamiliar destination. This also related to the definition of the problem stated by the investigators. For instance, Streff & Wallace asked their respondents regarding preference for travel information whereas Sheppard & Adams relied on their respondents to give the strategies they used to plan a route. In addition, Obata tried to get their respondents to give the content of information by asking them to sketch a map or provide written evidence on how to reach A from B. Meanwhile Gordon & Wood and Alm concentrated upon the environmental types of information in assisting drivers to achieve their goal. The difference in the way of examining the strategy and defining the problem might have caused the findings to vary.

3.8. Route Choice Studies

Many would agree that one of the reasons that people like to travel is the fact that different things exist in different places. Indeed, others would also agree if someone said that there is usually more than one way to travel between two places. For example, if someone would like to go to Jalan Tuanku Abdul Rahman, he or she can use Jalan Tun Perak or Jalan Imbi in order to reach there. Previous studies revealed that in every trips a driver make, in some ways or another, he has to make a route choice decision. In some cases these decisions are of minor importance to the traveller but in others they may be very important. The collective outcome of all individual decisions is often important to all of us because it affects the quality of the environment in which we act.

One of the typical examples of environmental deterioration caused by the collective outcome of individual route choice decisions is congested road. For example, on an individual level, we often experience situations in which we have to make a choice between alternative route, in both familiar and unfamiliar environments. For instance, to reach a destination, the traveller can choose between alternative route, and modes. For various reasons, he is not familiar with all of them, and of those he knows some are not suitable. From the remaining subset of routes, he will choose the one that seems best under particular circumstances. This sometimes necessitates a trade-off to be made among the various route aspects. Those, in turn, are affected by the collective behaviour of individuals as well as by other agents such as road maintenance authority or the police.

Based upon past studies, a route can be defined as a chain of consecutive road segments connected by node (which is equivalent to a chain of consecutive nodes connected by links).

Thus, the choice situation consists of all possible routes between a given origin and a given destination. Indeed, there exist three possible choice situations;

- the traveller chooses from among the entire routes between origin and destination; he makes his choice before starting and does not change it along the way. This procedure will be called simultaneous choice.

- by each decision point along the way the traveller chooses once again from among the sub-routes to his next decision point. The choices he makes at these points are independent of one another. An alternative now consists of a series of choices (e.g. independent, non-overlapping sub-routes). This is called sequential choice.

- the traveller makes his choice at the decision points, but his choice of behaviour is dependent upon previous choices. This is called hierarchical choice.

The above forms of route choice behaviour do occur in reality. In other words, complete routes as well as separate sub-routes may be the unit where travellers could choose. For example, Stern and Leiser (1988) have found that in cases where a complete route behaviour required a turn en route, drivers would change their original intention on the way and avoid turning at immediate nodes. Even in such cases one can see that only under very special circumstances the resulting behaviour will be independent of the specification of the choice situation, that is, if the preference is based on differences among characteristics of the alternatives.

However, a traveller can make an adaptive route choice which is different from the above specification of choice situation. This phenomenon refers to decisions taken by the traveller while on the road and is dependent on the changing circumstances that he encounters. For example, a traveller might alter his route choice along the way if at a particular moment he experiences greater delay than had been anticipated. Past studies demonstrated that in urban situations, for example, route choice depends on the colour of the traffic lights that are encountered along the way. Thus, we could assume that the process of adaptive route choice taken by drivers is particularly observed when they are under pressure. For instance, Sheffi et al (1982) indicated that choices are made in such cases at immediate nodes, mainly road intersections in which the driver chooses between continuing links according to the distance between him and the last queuing car in each of the links ahead.

The use of routes in a network is considered to be the result of a decision-making problem. For example, a traveller who makes a trip from point 1 to point 2 has to decide on the route to be taken. Traveller's decision-making problem consists of investigating his opportunities at hand and of making a choice based on available information. Thus, the decision process consists of two main parts: finding the alternatives, and making a choice among them, which leads to the use of a particular route. Each traveller is assumed to decide on his own and to optimise his personal satisfaction. The traveller will consider his own behaviour to be rational. His objective is the optimal satisfaction of his travel needs while making the best possible use of the alternative available to him.

However, past research, e.g. in the U.S, U.K. and others have shown that drivers face considerable difficulties in achieving optimum (i.e., minimum distance or time, or both) routes from their origin to their destination. For example, Robb (1987) identified five main sources of information which drivers could use in order to make route choices. They are road maps, signposts, personal knowledge, and advice from other people and broadcast traffic information. Even though information on route choice can be found from several sources, drivers frequently are unable to plan the most efficient route between two places. For example, from 75 per cent of the motorists in U.K. trying to seek the shortest or quickest route, only 59 per cent managed to achieve that aim (e.g. Wootton et al., 1981).

The traveller decides on his line of behaviour that he will follow as an individual with a 'free will', influenced by his objective environment and personal opinions. In fact, travel behaviour is influenced by four groups of factors, at both the objective and the subjective levels:

- the physical environment including the built-up surroundings, the network infrastructure etc. These will determine travel possibilities and their characteristics.

- the socio-demographic environment in which the traveller lives including his household characterised by participation in the work process, the modes of transport owned, age, etc. All these will determine the cognition and perception of travel opportunities and may also impose constraints on travelling.

- the normative environment including the set of norms, values and concept derived from society and in particular from the immediate surroundings of the traveller.

- the personal environment comprising of the personality of the decision-maker, which may caused the three factors mentioned above, together forming the objective situation, to be observed subjectively, and the information derived therefrom converted into a decision.

Figure 3.3. shows the basic factor influencing individual's travel behaviour. For example, in the case of route choice, the physical environment is predominant. The influence of the other three factors, although relevant, may be considered as secondary. One reason for this is that route choice decisions can usually be taken anonymously and independently. Thus, we could say that route choice is principally concerned with two factors:

- the traveller, with his subjective needs, experiences, preferences, perceptions, etc.;

- the physical environment, with its subjective opportunities and their characteristics.

For instance, there is a physical environment with many route alternatives for travelling from A to B. A traveller has only limited knowledge (cognition) of all the opportunities available. That cognition is associated with his personal experiences (feedback from usage of chosen routes) and his manner of acquiring information like reading maps, asking others, etc. The traveller will not always consider all known alternatives to be genuine alternatives. There may be constraints set by the traveller and his travel demand, which preclude certain alternatives. Some characteristics of those alternatives may not meet minimum demands. For example, there may be a time restriction or a demand for a petrol station en route.

The known alternatives that satisfy his constraints will form the choice set. This choice set is the set of available alternatives from which the traveller makes his choice under particular circumstances. The subjective value of these factors is derived from the objective attributes. The traveller will try to measure and evaluate the relevant attributes that influence his trade-off and choice. Nevertheless, some of his knowledge of attribute values is distorted images of the actual situation. Thus, the traveller's perception of relevant alternatives and their attributes are incomplete and inaccurate. As mentioned earlier, his perception is linked to his travel experience and preferences. However, not all relevant characteristics are equally important to the traveller in making a decision. In his view, some characteristics will compensate each other to a certain degree. This may be expressed in the relative value that he gives them: high or low, positive or negative. Once the relevant alternatives of criteria have been ordered, the traveller is able to decide on the route to be used, according to a certain rule.

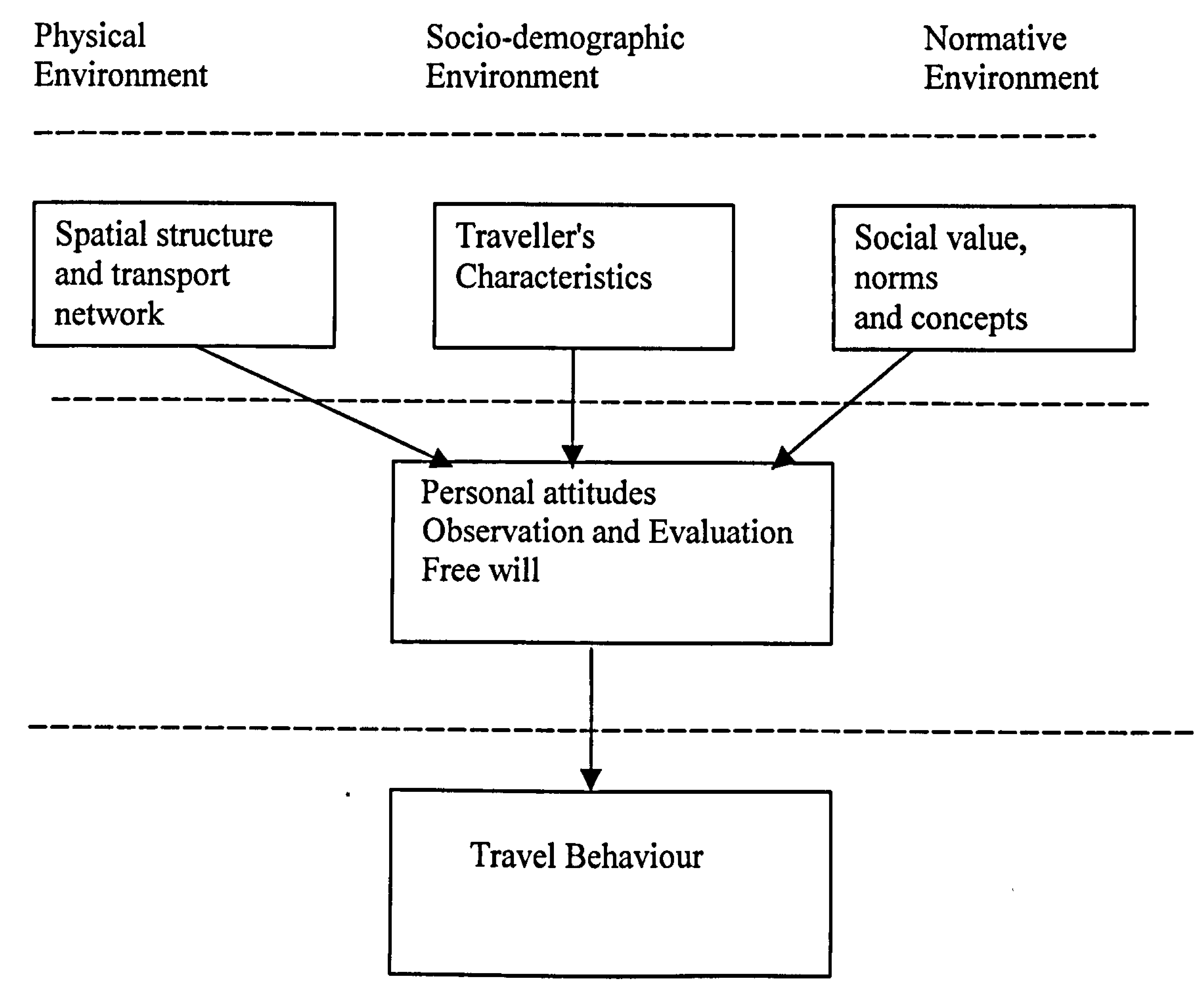


Figure 3.3 - Basic factors influencing individual travel behaviour

However, it is expected from the nature of the choice process that route selection is a very personal matter, and therefore, strong individual differences in preference and behaviour will occur which cannot be easily reduced to observable characteristics such as age or sex. This diversity is caused by other factor such as cognition, perception and evaluation that differ from each individual to another. Nevertheless, despite these strong idiosyncrasies, different individuals may take the same decision, that is choose the same route, though on different grounds.

Indeed, this study of route choice behaviour was primarily oriented towards gaining insight into driver's spatial choice behaviour. For instance, how do people choose routes in a network, what do they know, what do they look for, which road characteristics play a role? The researcher is only interested in investigating what are the criteria that driver used in selecting a certain route to several different types of trips, such as home to work and unfamiliar destination. For example, past studies have shown that relevant alternative or criteria has been used in choosing the best possible routes to certain destination, such as time, shortness and others (e.g. Benshoof, 1970). Thus, the study could be used as the stepping stone for other studies in Malaysia because there have been no study concerning route choice reported so far. For the purpose of this research, route choice criteria refers to the alternative or criteria that driver used in influencing them in choosing a route.

3.8.1. Route Choice Criteria Research

Many studies were interested in investigating the criteria that driver use in selecting a route. For example, criteria such as travel time is a better indicator of route choice than travel distance (e.g. Trueblood, 1952). However, Moskowitz (1956) found that travellers may not chose routes only according to two criteria, e.g. travel time and travel distance. He found that drivers expressed the thought of "shortness"; nevertheless, shortness in distance was confused with shortness in time. Meanwhile, Benshoof (1970) intended to identify the decision process actually employed by drivers in route selection. Drivers were asked why they chose their particular travel route on repeated trips (e.g., commuting). The most common response was, "the route is the quickest". However, less than one-third of the respondents gave this reason. Other responses indicated by respondents were "It is the shortest route", It has less traffic than other routes", and " I need to make fewer stops". According to driver's own criteria, they frequently chose incorrect routes. For example, of the persons stating their route was the quickest, 82.3% actually used the quickest route. In addition, only 39.8% of the drivers stating they chose the shortest route actually chose the shortest route. Similar with Moskowitz's'study, it appears that the idea of shortness in distance is confused with shortness in time. The implications from both studies are that drivers gave different kind of criteria in order to select a route. In addition, drivers have difficulty in measuring objectively these criteria. For instance, many drivers were confused with the criteria of shortness, e.g. shortness of distance vs shortness of time.

A study by Wachs (1967) revealed that there were various reasons why drivers made route choices. He found that the reasons differ from one trip purpose to another. For instance, in work-visit trips, reasons for route choices stated by the respondents were: -

- greater safety,
- shorter distance,
- more pleasant scenery and
- smoother pavement.

He also found that the reason cited by drivers for visit-shops trips, which comprised: -

- more pleasant scenery and
- more stores, services stations etc.

Similar to Benshoof study, Wachs findings also revealed the variety of criteria or reasons employed by drivers in determining the appropriate route to use. Thus, we could say that drivers would employ or choose different kinds of criteria for different kind of trips, as evidence in Wachs (1967) study. However, one could argue that there might be other factors, which could influence a driver's decision. For example, while commuting to work, traveller would like to shorten their journey distance in order to minimise time constraint, e.g. able to arrive on time at work. While for other trips, e.g. visit or shop trips, probably the driver would like to see more pleasant scenery rather than being trapped in congested roads.

As mentioned earlier, a driver would use various criteria in choosing a route. Indeed, Bovy & Stern (1990) also found that people's preferences for various route characteristics vary. It can be related to the characteristics of the travellers, their trips, and the routes to which they have been exposed. The differences seemed to be related to the great importance of direct and quick access to the destination in the trip to work, and increasing importance of amenities, such as comfort and pleasant scenery, more leisurely social recreation and shopping trips. For example, Ulrich (1974) found that scenery, was the most important non-economic factor in shopping trips.

Relating to the above studies, e.g. Wachs (1967) and Benshoof (1970) showed the difficulties in arriving at universal conclusion about the relative importance of choice attributes for route choice. It is perhaps due to different ways and contexts in which choice attributes had been studied. Benshoof (1970) used a closed-type of questionnaire allowing for nine pre-determined reasons. On the other hand, Stern and Leiser (1988) used an open-type questionnaire forcing respondents to come up with their own reasons. Thus, different kind of instruments, e.g. questionnaire and definitions of route choice criteria, may result in different findings as showed in the past studies.

Janssen & Van der Horst (1992) sought to determine the effects on drivers' inclinations to diverge from their normal routes when descriptive messages from Variable Messages Signs (VMS) of different reliability were encountered. Their reliability in their study was defined in terms of the degree of correlation between the information provided on the VMS sign and the driver's subsequent experience on the chosen alternative, that is, the actual arrival time. The independent variables of information presentation mode (three-levels) and reliability (three levels) were manipulated between drivers. Respondents were presented with route-choice decisions while driving in the simulators. Their behaviour was measured at the decision locations so that the experiment would yield findings not only in terms of route choices but also on the relation between route choice and actual driving behaviour.

Their study showed that the form in which descriptive information were given, the reliability of the information, as well as the content of the information determine whether a driver would diverge from the normal route. There was an overall increasing tendency to diverge when signing indicated worsening conditions on the normal route. They also found that driver's inclination to diverge was also sensitive to certain conditions in which a particular type of information came in conjunction with a particular level of reliability. Thus, although inherent reliability was of little effect in the travel time mode, reliability matters a lot when information was given as length of congestion. The reason for this presumably was that the user optimum was easier to find when information was in the form of expected travel times, or delays relative to normal travel times than when it was in the form of kilometres of congestion.

They also indicated that analysis of driving speed on the approach section to the decision point showed that the display of information indicating congestion on the normal route caused a slight increase in speed (3.8 km/hr). This may be interpreted as an anticipatory action in the face of an expected time loss, irrespective of the actual choice made at the decision point. The finding showed that the increase in speed tended to rise with indicated severity of the congestion. Thus, there appears to be a link between the displayed descriptive information and the driving behaviour on the approach of the decision point.

From their study, several conclusions could be drawn such as:

- by providing descriptive information on VMSs results in diversion rates that are sharply differentiated according to prevailing conditions so that they offer a high potential for the fine-tuning of traffic streams to capacities in more or less critical route choice configurations,
- by supplying descriptive information in the form of expected travel time is relatively insensitive to degradation in the reliability of the information,
- by offering descriptive information in the form of congestion length in kilometres is relatively sensitive to degradation in reliability, and
- driving speed towards the decision point increases slightly when VMS indicates congestion on the normal route.

The above studies clearly show that the different reliability and content of information may influence drivers' decisions to divert. In addition, the use of VMS in presenting the messages could be one of the factors that had affected a driver's response. Thus, designers of information systems should be able to address the issues of reliability and content of information thoroughly because drivers find it easier to locate information in terms of expected travel time or delays, e.g. length of congestion.

Emmerink, Njkamp, Rietveld and Van Ommeren (1996) conducted a survey which attempted to analyse the impacts of both radio traffic information and Variable Message Sign. A total of 2145 questionnaires were distributed and 826 were returned with a response rate of 38.5%. In summary, the sample consisted mainly of 25-60 years old full time male workers. They also found that their respondents were influenced by the radio traffic information and opted for an alternative route, such the associated level of satisfaction was likely to be large if: (a) the alternative route was still on the motor way, and (b) the alternative route was not much longer in distance than the original route. Their study provides an insight in term of method that can influence route choice behaviour. Radio traffic information plays an important role in determining drivers route choice behaviour. Their findings also confirmed findings of other studies, e.g. Spyridakis, et al. 1991 & Khattak, et al. 1993.

Wallace and Streff (1993) intended to investigate several aspects regarding drivers diversion behaviour, for example; (a) when do drivers consider to divert, and (b) what pieces of information do drivers want to have available when making their decision on whether or not to divert. In order to address these issues, they conducted a survey which asked respondents to indicate their tolerance for delay and to rate the importance of thirty-three considerations or information 'bits' in the decision of whether or not to divert. They divided the survey into three sections which, were: commuters' survey, familiar-areas survey and unfamiliar areas survey.

Their result shows that overall, familiar areas respondents had a smaller range from highest to lowest importance score, suggesting that commuters may be more focused in their information needs; that is, the need to arrive at work on time outweighs all other potentially important concerns. They also found that characteristics of delay on the original route were rated highest on the commuter survey; characteristics of the alternative route placed at the top for the familiar-area survey, and delay characteristics of the original route also ranked high and next in importance. Their result may suggest that commuters may have tendency to divert from a congested route, whereas non-commuters travelling in familiar areas may want to know more about the route that they would follow if they diverted.

Their study also provided some important aspects in revealing drivers' willingness to divert from usually congested routes. For all three-survey types, drivers' willingness to divert from congested routes was determined by the type of trip they make, i.e., commuting trip or unfamiliar journey. Drivers' information requirements for diversion decisions also vary by trip type. This means that different kind of trips, i.e.; commuting and unfamiliar trips require different kind of information. Therefore, for developing drivers information systems, the systems must be designed with the capability of providing a large amount of information, and that drivers need the freedom to choose which pieces of information would be accessed at any given time. For example, in unfamiliar areas, drivers might need route guidance information; while drivers on commuting trip, might need route characteristic information (e.g. congestion levels or travel times).

The studies by Benshoof (1970), Geehan & Deslauriers (1978) and Bronzaft et al (1976) showed a dimension of skill in the route choice decision. For instance, Benshoof found that some travellers who thought they had chosen the fastest route had not actually done so. In addition, Geehan & Deslauriers found that some persons were unable to use available transit information to plan their routes. However, Bronzaft et al. found that some chose indirect or mistaken routes when using subway maps. Consensus from the above studies showed that motorists might have different skill and requirements when making route choice. In addition, their route choice selection may be influenced by certain factors, e.g. availability of information regarding the route, demographics aspects and the route itself.

Stern and Leiser (1989) found that the relative importance of choice attributes also vary, with the length of the trip to be taken. In their study, perceived (subjective) travel time has been found the most affecting attribute in short-route situations and the number of turns has been respectively found in medium-length situations. For respondents who perceive the route length in physical distance, the total travel time is the most important attribute in long distance choice situations. For drivers who perceive it in terms of time, the total 'delay time' (e.g., waiting time en route due to stop signs, traffic lights, congestion, etc) is the most important attribute. Indeed, choice factors among the drivers of private vehicles, commercial vehicles or public vehicles also vary. The characteristics of the vehicle and the trips showed that choice factors among the above drivers' are different. Private vehicle drivers might need or have different route choice selection criteria compared to both commercial drivers and public transport vehicles (Bovy & Stern, 1990).

Based upon the past studies, drivers would employ variety of criteria in selecting a route. In addition, some researchers found that drivers would choose a route based upon time factor (e.g. travel time criteria) while others found that drivers would use distance factors (e.g. saving mileage or reducing mileage). Furthermore, past studies also showed that route choice criteria is measured by using several approaches, e.g. from survey to experiments. This resulted in different findings regarding drivers' route choice criteria. However, this thesis was only concerned with the route choice criteria or route selection criteria's used by the drivers on several types of journey, e.g. commuting and unfamiliar trips. The study would highlight some important elements of Malaysian drivers' route selection criteria for certain trips. The information regarding drivers route selection criteria would help the responsible agencies, i.e. Ministry of Public Works and Ministry of Transport to design some systems or traffic facilities that will help drivers to make better decisions and helping them finding optimal route to use.

3.8.2. Discussion - Route choice criteria

Table 3.7 summarises the nature of the key studies described above and the criteria that drivers used in selecting a route. The table shows the different set of good criteria used by drivers in selecting a route to their destination. By comparing those studies, it is important to note that drivers would employ different set of criteria. Thus, we could suggest that different drivers might use different set of criteria. Stern & Lieser found different criteria were used by different categories of drivers, whether they are private, commercial or dispatchers. It is also similar in the case of traffic information where different categories of drivers may want different kinds of information.

In addition to the above issues, different set of criteria was also dependent upon types of trips that drivers attached to. For example, in comparing studies between Benshoof and Wachs, we could see the differences of criteria used by drivers, even though on the same commuting trips. This may be attribute to the nature of different trips or road in each study. Benshoof study was in Newcastle, U.K. whereas Wachs in Illinois, U.S. This different environment may influence the different criteria used. Indeed, Stern & Lieser also found the astounding evidence that shows different trip might prompt different kind of criteria.

Table 3.7 - Summary of studies regarding route choice criteria

Authors	Nature of study	Good criteria
Trueblood (1952)	Experiment - choice of route for commuting trips	Travel time
Benshoof (1970)	Survey - reason of choosing a route for commuting trips	Quickest, shortest, less traffic & fewest stops
Wachs ('1968)	Survey - reason of choosing route	Work trips - safety & shorter distance Visit & shop trips - pleasant scenery, more stores
Janssen & van der Horst (1992)	Experiment/road based VMS - to influence route choice	Information on length of congestion, travel times
Stern & Leiser	Experiment-important of choice attributes (e.g. also vary in term of categorisation of drivers)	Vary based on trip types, e.g. short route - travel time medium route - number of turn long route - total travel time

However, these contradictory results perhaps may be the influence in which they were measured. For example, some of them were using experimental measures and others used subjective measures such as questionnaire. Thus, it is important to employ a method, which is applicable to all kind of environments and context, in term of countries. In addition, some studies also found that the use of VMS and radio traffic information could also influence drivers route choice. For instance, travel times and length of congestion may prompt drivers to make changes in their decision or route choice/selection. Thus, secondary information sources may influence driver's decision to select a route. Nevertheless, the difference in which route choice criteria were defined may influence a driver's decision to use some set of criteria in selecting a route. This was also related to which context and method used to investigate one's route choice criteria.

3.9. Methodology Issues

Survey

There are three main methodological issues in survey research and they are coverage, method of data collection and method of analysis and interpretation (Moser & Kalton, 1971). Consideration of survey objectives and available resources guide decisions about methodology. With respect to coverage, the research was interested in information requirements amongst drivers, particularly commuters. There are three major survey research methods: postal questionnaire, personal interview and telephone survey (Bourque & Clark, 1992). Each of the methods has its advantages and drawbacks. For example, the postal survey is a very low cost technique. Other postal survey advantages include avoiding interviewer-biasing errors, can be anonymous and provide good accessibility to respondents. In addition, it also provides an opportunity for respondents to take time to consider responses. However, the disadvantages of the technique are potentially low response rates and the inability to query or probe response.

Whereas interviews by telephone or in person is of an advantage as it is flexible and allows the interviewers to clarify questions and probe response (Frankfort-Nachmais & Nachmais, 1992). Interviews also offer greater control over the sequence of questions and usually have high response rates. Another advantage of using interview survey is that researchers can collect more information, and get more complex information from more subjects. Interviewer's also can select respondents and control the order in which data is obtained. However, the cost of training, paying, and supervising interviewers are the major disadvantages of both in-person and telephone interviews. Other problem is concerned the data processing, which is likely to take longer and to cost more. Nevertheless, the main disadvantages of these survey methods are the lack of anonymity and risk of interviewer's bias in response.

Based on the literature, the majority of the studies used surveys as their main method. Their techniques could be divided into three main techniques, e.g. postal, interview and telephone survey. Indeed, the number of respondents participated in the study also varies, ranging from 30 subjects to more than 2000 respondents depending upon the nature and sponsorship of the study. Nevertheless, there are varieties of factors that influence the selection of data collection, e.g. sample size and cost (in fact both elements are related to the survey administration method). Thus, the investigator has to decide upon which method to employ based upon their capabilities.

As mentioned earlier, there are advantages and disadvantages of using survey as the data collection procedure. For example, a majority study in the literature used questionnaire to elicit relevant data on information requirements. Problems associated with the use of questionnaires as the data collection techniques are:

- Respondents could only comment based upon their experiences which vary among themselves (in fact their experiences could be used in developing user information requirement specification).
- Sometimes their responses were based upon hypothetical situation which is different compared to real-life situation (thus, the response may be biased or could be argued).
- Some term used in the studies could have different meanings or they only cover one aspect which could prevent detail measurements regarding the aspects.
- Response rates are an important aspect because if the survey has low response rate, it could threaten generalisability of the survey to the population from which the sample is selected.
- The reliability and validity of data collected depend upon respondents memories and forthrightness (e.g. Bourque & Clark, 1992).

The above list is important when one intends to employ survey as the main method to collect data concerning drivers' information requirements. Although, surveys seem to have many sorts of problems, it could provide an idea from the target respondents regarding their needs. The data from the survey also could be useful in determining a driver's response in hypothetical situations, i.e. stated preference approach. This approach could help investigator in examining the issues; i.e. information needs in more detail manner such as simulations, laboratory experiments and field study.

Thus, the data collected by employing survey method could provide relevant and vital information that might help in determining drivers information requirements based upon their various types of journey. It is hoped that this study could provide relevant information concerning local drivers information requirements, which may be different, compared to other countries, e.g. Japan or U.K.

Motorists Information Requirements

There are a lot of studies that investigate drivers' information requirements. Indeed, the variety of methods employed by an investigator revealed different kinds of information that drivers required. For example, Penttinen et al., (1996) used telephone interview and found that drivers required different types of information for different kinds of journey. In addition, Conquest et al., (1993) also confirmed that among the same group of drivers, their information needs varied according to their individual characteristics. The majority of studies that investigated motorists information requirements employed questionnaire as their main tool to sought information (e.g. Spyridakis et al., 1991 & Tsai, 1991). In fact, the easiest way to identify drivers' information needs is to ask directly the potential users, i.e. the driver. In addition, this kind of approach seems reasonable, cheap and very effective to discover their information needs. However, questionnaires are used to collect data that are unavailable in written record or cannot be readily observed. In fact, questionnaires can be used only when respondents are available and willing to participate as research subjects.

Some of the problems related to the use of variety of types of methods in determining drivers' information requirements are the different findings regarding their studies. For instance, Streff & Wallace found different types of information were needed similar to the case of Penttinen et al, which also found different kinds of information. However, one could argue these findings because of the nature they asked these questions (i.e. regarding information requirements) to the respondents in each study. Indeed, different context in which the study was conducted is one of the possible explanations of differences observed between one study to another. Related to the above issue, one could also note that investigators differed in terms of how they defined information requirements. Indeed, as Tsai and Mannering et al found that different class of drivers would also require different set of information. Thus, it is not wise or suitable just to employ one kind of method to sought information that drivers need. It is because with the employing of different types of methods could increase confidence that data obtained correspond to the real phenomena.

Past studies also differed in the number of the participants need to be included in their study. Some even mentioned the need to have a larger sample so that appropriate conclusion could be drawn. However, the majority of sample used by previous investigators ranged from 500 to 3000 subjects. Although, the numbers were quite high, the conclusion should be treated with caution. It is because some of it may not well represent the whole motorists population. It could be well applied in Malaysia, where the results of other countries such as the U.K., U.S. or Japan could not be used as the right choice. Instead, they could be used as a guidance for local study regarding several issues, which need to be addressed concerning drivers' information requirements.

Timing and method to present the information

Past studies also revealed that several investigators have used surveys in investigating the timing and method to present the information. However, the use of survey has prevented a thorough investigation on the issues of timing and method to present the information. In other words, a survey could not investigate objectively regarding the best timing to present the information and from what method the information should be presented. In reality, both issues are related to each other. The study had to use surveys because there is no other suitable methods to investigate the timing of information and medium to present that information. In theory, the response given by respondents in the survey was enough to know when they need that information. However, one could argue the sensitivity or reliability of this information/response.

Previous works concentrated upon the use of the variety of objective methods such as road-based environments rather than subjective measures, which focuses upon driver memories/experience and opinion. For example, in the case of investigating route guidance instruction, Zaidel (1991) believes that road-based studies should be used for any research that evaluates the implications of systems for road safety. Indeed, this method has produced good results concerning the timing and appropriate method to present the information. Thus, the responses given in this thesis regarding the possible timing and method to present information should be treated with caution. The findings might be well questionable because of the nature of its being investigated. However, the information may be used in conducting future study regarding the suitability of presenting variety of types of information by using only one medium.

Navigation Strategies

Navigation itself comprised several activities such as route planning and wayfinding. Thus, it was predicted that strategies used in these two activities might be different. Indeed, this study only focuses upon the strategies used by drivers in three different settings. This may be different compared to previous works which also investigated drivers navigation strategies. Thus, different setting and context in which the aspects were being studied may result in different findings. For example, others use some objective approaches that may result in more accurate findings compared to the subjective measures such as survey or interview which only asked drivers their navigation strategies.

In fact, previous works also predicted that the strategies drivers use have different impact on their navigation performance. However, this study did not measure drivers' performance when using certain strategies because of no available material which could be used as guidance in developing such measures, e.g. investigating a driver's performance. In addition, there are no studies reported so far that could be used or to compared with. Thus, there is a need to employ more objective approach rather than subjective measures of which the information may be questionable (i.e. whether respondents actually used that strategies or not). Nevertheless, it is hoped that the information gathered from this study could be used for other studies especially in local context to further investigate these issues. Hence, there is also a need to use more specific approaches or combination of approaches in order to collect vital and relevant information.

Route Choice Criteria

Previous works have concentrated on this issue, e.g. route choice criteria and came out with a variety of criteria that drivers used when selecting a route. Indeed, these criteria were used in the survey in order to investigate local driver's route choice selection. Although, some criteria may be relevant to the condition or situations in local environments, one question arose, for example, did the criteria really refer to what they were? Is more relaxing routes in other countries, e.g. the U.S. is similar in Malaysia. This different term may well be confounding elements in the response given by the respondents. In fact, previous works also differed in term of how to define criteria that drivers used in selecting a route. In addition, drivers themselves also differed in defining the criteria that they would use in choosing certain route. Thus, one may argue the responses given by respondents in this survey.

As mentioned earlier, the study use a survey method to measure the criteria that drivers used in selecting a route in different types of journey purposes. There is evidence from previous studies that employing different kinds of techniques may result in different kinds of results. Thus, the study may come out with different findings, which may be different from other studies. Indeed, the study is new in Malaysia where drivers were not certain regarding the term used in the questionnaires; e.g. " What attributes did you used in choosing a route". Consequently, the use of survey may not be the suitable method to elicit this kind of information. However, because it would serve as a pioneer for other studies, it was hoped that this study could develop more relevant information regarding these issues and relating to the local context.

3.10. Summary of the literature review

In general terms, the literature illustrates some of the studies regarding the aims of this research. Specifically, the following points could be made, relevant to each of the main heading of the review: -

Information requirements

- Many studies are concentrated upon various aspects of information requirements. In other words, different types of methods were used in eliciting information regarding information needs. However, such methods led to results which were dependent on the context in which they were examined. Indeed, various contexts in which the issues were investigated have enriched the knowledge regarding the information that drivers required. However, the questions that arise were about the suitability of the method and findings to the overall road situation, e.g. real-life traffic situation.

- Related to the above issues, e.g. method used in extracting potential data about drivers' information requirements, different categories of drivers may influence the findings itself. As evidence in the literature is that different drivers may require different kinds of information. Indeed, it is well related to the issues of nature of the trip in which drivers made, e.g. commuting vs. unfamiliar trips. Thus, there are pro and cons of each methods, and it is suggested that other investigators should use both methods, e.g. subjective and objective to investigate the 'content' of information issue fully.

- Various investigators had employed a variety of categorisation of information. For example, Streff & Wallace came out with 33 bit of information that drivers found to be important in making decision whether to divert. This categorisation may be inconclusive since there would be other bit of information, which had been neglected or never mentioned by respondents. It also applies to other studies which came out with various information requirements which need to be categorised as to which is important or unimportant.

- There had been no human factors work considering the characteristics that makes particular information suitable/appropriate for certain trip, e.g. unfamiliar trips. Rather, lists of the most commonly reported information needs have been drawn up from a sample group of drivers. This leads to results, which are wholly environment, country and study specific.

- Furthermore, it must be noted that all of those studies with comments regarding information needs have been non-local, and the applicability of their findings to this country must be questioned.

Information presentation

This section comprised the summary of the literature concerning both timing and method to present the information to the drivers.

- There has been little direct work regarding how to present particular types of information to drivers (e.g. length of congestion, location of alternative route). If certain information is to be commonplace within the drivers information systems of the future, then it will be important that standardised means of presenting such information are developed.

- In addition to the above issues, little research also has been done in investigating the appropriate timing to present the information (e.g. length of congestion etc). Indeed, many studies concentrated upon the timing of route guidance instruction in order to develop a systematic route guidance system. Although, the finding is useful in term of guiding investigator, it is not suitable because of the different nature or content of information being investigated. Thus, there is a need for a thorough study to examine these issues.

- Indeed, previous works also had concentrated on several types of medium to present the information. Each medium has its pro and cons, which need to be investigated further regarding the suitability of presenting certain information to drivers. Furthermore, most of the studies focused upon one medium and not comparing the effectiveness of different systems in relating to the performance of presenting certain information. Thus, the data concerning the systems would not be useful in determining the suitable medium to present the information.

- Finally, drivers participated in the previous works had experience with some kinds of systems, e.g. commercial radio, in-vehicle systems or VMS. Whereas in Malaysia, these systems have yet to be available or fully operated. Thus, their applicability or suitability of the response made by those drivers may be questionable.

Navigation strategies

- Many studies have been done in investigating strategies used in route planning and wayfinding in unfamiliar destinations. However, because of the variety of the nature of the studies being conducted, they were various findings regarding the results of these studies. There are no standard strategies that drivers would use in certain types of situations. Indeed, these strategies may be different compared to the strategies used by the local drivers (however there is no reported study that can claimed this assumption).

- Different use of strategies may be dependent upon the context in which the navigation strategies were measured. Some measured it based upon the experience of the respondents (i.e. survey) and others used objective method (e.g. experiments). Thus, different approaches as a means of extracting information on strategies may result in drivers using different strategies in various situations. This on the other hand may well enrich investigators' knowledge regarding navigation strategies used by drivers in several different situations. However, on the other continuum, the applicability of the findings may not be useful because of the limited context in which they were measured.

- Different strategies used in the navigation may well have some effect toward the performance of those who employed those strategies. However, one may argue the performance of these drivers because of limited confidence regarding the performance data. It is because of the limited scope of which the navigation task was measured. For example, Alm (1990) asked respondents regarding route descriptions in Sweden. These descriptions might be different compared to other countries. Thus, the information may not relate to the local conditions.

- There has been no human factors work considering the attributes that make particular strategies useful for navigation, e.g. route planning and wayfinding. In addition, as mentioned earlier, these studies reported in the literature may not be suitable in Malaysia because of different unfamiliar destinations where different road situation or driving culture may hinder the findings to be used in local context.

Route choice criteria

- There are several important findings on these issues, e.g. criteria that drivers used in selecting a route for several different types of journey. For example, previous works revealed that even within the driver group itself, they would use different kinds of criteria. In addition, different types of trips also prompted the use of different criteria. Thus, it is suggested that the information systems should be able to present the different criteria to different categories of drivers in different trip purposes.

- In order to achieve this, there is a need to establish or examine how to present a particular types of criteria to drivers (safety, more relaxing routes, quickest etc). If certain criterion is to be commonplace within the information systems of the future, then it will be important for future studies to investigate this matter before it could be used by its end-users.

- The study of route choice criteria is simply looking at the knowledge used by drivers in selecting a route. However, this knowledge has not been examined thoroughly or carefully so as to generates a complete information regarding criteria used by drivers. This is partly because of different kinds of methods used in eliciting the required information from the target audiences. Thus, the information varies. It also may not be suitable to the local context because of different definitions regarding the criteria that drivers used by previous investigators.

3.11. Chapter Conclusion

A prerequisite element in developing acceptable motorists information systems is to understand and identify the problem, e.g. information requirements of drivers. Although, some research had been done to determine the nature of the problem, its findings could only be applied as a guidance. Therefore, a local study especially regarding the needs of information required by the resident drivers must be established, e.g. in Malaysia. This study would help to determine information specification for several journey purposes, e.g. commuting trips. Past studies revealed that those drivers themselves are not homogenous; thus, their needs for information could also differ among each other. In addition, the information requirement varies according to the nature of the trips. It is believed that drivers in commuting trips do require different information, for instance for home to work and vice versa. Based on this premise, it is suggested that the nature of trip purposes may influence the needs for different types of information. This differential information requirement makes drivers belong to special group, e.g. pre-trip versus route-changers.

The thesis is also interested in investigating drivers' navigational activities, e.g. wayfinding. The study is only focused upon the strategies that drivers would use in unfamiliar environments. In addition, the thesis also intends to examine the criteria that drivers used in selecting a route for several types of journey. Past studies revealed that different strategies were used in navigational activities. Similarly, drivers also employed variety of types of criteria when trying to search or select appropriate route for certain types of journey. However, these problems have not been fully understood by local researcher. Thus, more research needs to be conducted to examine these issues especially in Malaysia in order to develop the so-called user centred systems. The following chapters described the research that addressed these issues.

Chapter 4: Preliminary Studies

4.1. Chapter Summary

This chapter reports a preliminary investigation into drivers' information requirements. Several methods were used; e.g., focus group discussion, exploratory interview, postal survey and interview survey. Several topics, i.e. driver information needs, possible timing and method to present the information, route planning strategies and demographics aspects were investigated. The study showed that drivers require various types of information such as congestion, weather and parking information. Results from the preliminary studies were used in the development of the main survey described in the following chapter.

4.2. Introduction

Driving requires the performance of a non-trivial set of subtasks of the driving task. There are three main levels of tasks in driving, which are navigation, maneuvering and control. These three different levels of driving task require different types of information as evidenced in Allen et al., study (1968). In addition, Berge et al., (1992) also found that there are variety of level of information that a driver might require. Although, there have been some studies that contribute to the knowledge of what kind of information that a driver requires (e.g. Spyridakis et al., 1991 & Penttinen et al., 1996), these studies could only be used as a guideline in investigating local driver information needs. Different environment and context of the studies could be a source of differences between local, e.g. Malaysia and developed countries, e.g. the U.S., U.K. or Europe regarding drivers' information requirements. In spite of that, these studies contained several interesting insights which could help local investigator regarding these issues.

The answer to the question regarding what kind of information do drivers need seems to be very simple, namely: all information, which leads to safe driving. However, one might argued what kind of information would it be or in which modality should it be presented. Several studies were conducted to investigate motorists information requirements (e.g., Streff and Wallace, 1993; Mannering et al. 1995). Based upon their results, it was suggested that there were various factors that need to be investigated in relation to the motorists' information requirements. For example, types of journey or categories of drivers need to be addressed thoroughly if one intends to investigate driver information requirements. Thus, logically drivers would require different kind of information for different type of trips (e.g. Streff & Wallace, 1993). Thereupon, more research is necessary in order to gain knowledge regarding drivers' information requirements.

The studies reported in this chapter were conducted to gain a qualitative awareness and exploration of these problems. The limited knowledge in this area necessitated a flexible and exploratory method for conducting a preliminary examination of the issues. This preliminary study had employed several techniques in an attempt to understand drivers ' information requirements. The study reported in this chapter was conceived as a means of providing an initial context to the thesis. Several methods were chosen. These methods have their merit and drawbacks. Information from the methods provides guidance in selecting appropriate method for the main survey. In the present study, focus group discussion, exploratory interview, postal and interview surveys were conducted on drivers in Kuala Lumpur, Malaysia.

4.3. Aims of the Study

The preliminary study main aims were to explore several aspects which includes to seek information that drivers require in certain situation, e.g. dealing with congestion, making commuting trips and driving to unfamiliar destination. It also covered several issues such as the possible method that drivers prefer to present the information they required and the appropriate timing of presenting the information and finally, it is also intended to find out drivers' route planning strategies in an unfamiliar environment.

In addition, the preliminary study also had several secondary aims which tried to investigate drivers' opinion and experience regarding congestion especially in Kuala Lumpur and its surrounding areas and it also tried to discover respondents knowledge regarding new technologies in vehicle and plans to minimise congestion.

Most of the aims were covered in all the methods employed in this study. The reason for employing more than one strategy were to gain greater knowledge regarding the information that drivers require. It is evidenced from the past studies that different approaches employed by researchers resulted in different findings. For example, Penttinen et al., (1996) used telephone interview to come out with different types of information compared to Streff & Wallace (1993) who used postal survey. Thus, it was expected that from the nature of approaches used in the preliminary studies would resulted with variety of types of information that drivers require. This would help local investigators to design or to know what kind of information should be presented to drivers.

In addition, the need for several types of methods was to gain knowledge regarding the advantages and disadvantages of using them in the major studies. Thus, the researcher could have first hand knowledge before choosing the appropriate method for the major study. This certainly would reduce the amount of time spent in searching and selecting the appropriate approach. Besides that, the information gathered from the preliminary would be used in the major study with the aims that only the relevant information would be collected.

Nevertheless, the approaches were employed because they were providing a complementary insights and information regarding the aims of the preliminary studies. All methods in the preliminary studies employed the same population, e.g. motorists/commuters. Thus, it was assumed that the information given by the participants were the same although by using different type of methods. In addition, the variety of methods used could help investigator in several ways such as sampling procedures, which technique of collecting data to be employed for the main study and future problems that need to be anticipated regarding the method used in this research.

4.4. Method 1: Focus Group Discussion

There were 12 participants in total, 8 of whom were males and 4 females. All held valid driving licences. They were divided into 2 groups. Group 1 participants age ranged from 29 to 47 years ($n = 6$, $\underline{M} = 35$ years). Age of group 2 participants were ranged from 23 to 44 years ($n = 6$, $\underline{M} = 29$ years). Participants were recruited through drivers motoring organisation. They volunteered for the discussion and were paid for their participation.

Two research assistants were assigned to both groups. The role of research assistants was to introduce items in the discussion and motivate participants to discuss the topics in the discussion. Discussions were held in Bahasa Malaysia. The topics of discussion were about their opinion concerning congestion, experience when trapped or faced with congestion and finally, participants were asked regarding their opinion on new technology in vehicles. In this section, respondents were also prompted to discuss their information requirements (See Appendix 1). The discussions were recorded on an audiocassette recorder and transcribed later. They were set to last 90 minutes. Complete transcripts of the recorded discussion were made. The content of the discussions were reviewed and classified into themes based on the aims of the group discussions. The content was translated from Bahasa Malaysia to English. There were 20 pages of transcribed text, which amounted to almost 5,000 words of discussion.

Opinion and Experience toward Congestion

The majority of the respondents agreed that congestion was getting worse from time to time. For instance, in 1970s the congestion occurred at 7.45 a.m. to 8.30 a.m. but now it starts as early as at 6.45 a.m. and ends at 9.30 a.m. in some places. Others say that congestion could become worse when it rained. Some of the participants said that they were quite annoyed and frustrated when trapped in congestion especially a long one – more than 1 hour. There were incidents when some of the participants had to break their fast in their car (i.e. in Ramadhan month when the Muslim fast), whereas some of the participants were quite happy with the congestion because they could work overtime.

Plan/Method to minimise congestion

Respondents' responses were varied. However, most participants agreed that there should be a better way to minimize the congestion especially during rush hour, i.e. morning and evening. Some said that more roads should be built in order to accommodate the rising number of vehicles. Still, others disagreed because they would have to pay toll in order to use the new road. In fact, when this group discussion began, works had begun for developing new roads in Kuala Lumpur and its surrounding areas, e.g. Kajang and Ampang. Some of the respondents even mentioned road pricing, i.e. issuing a fare to all vehicles to entering city centres like Singapore. Nevertheless, others were very doubtful regarding the plan to curb/minimise congestion. It is because the plan itself had already been delayed several times. However, they agree that something needs to be done in minimising this problem, e.g. congestion.

New Technologies in Vehicles

The respondents also discussed their views on new technologies in vehicles. The findings show that some respondents did not know about new technologies in vehicles, e.g. route guidance, while others seemed to know but they were not quite certain the availability or existence of the systems. However, some drivers indicated they may or sometime listened to local radio station on traffic information. Nevertheless, respondents seemed to like the idea of having new technologies in their car which help them, while others seemed reluctant, for example, they think that more study was needed regarding the advantages and drawbacks of the technologies to human. Indeed, they were also doubtful regarding the effectiveness of the systems, e.g. too many cars receiving same messages may influence the flow of traffic and they may get stuck in congestion again.

Information Requirements

Respondents discussed the information that they would prefer especially during congestion. Information that drivers think as useful in helping them when face with congestion were varied based upon their own experiences and expectation. Information such as traffic condition, congestion and other aspects related to it, e.g. how, when, where and the duration of the congestion. In addition, respondents also listed the need for parking guidance, alternative routes and route guidance information. Nevertheless, the study also shows that different respondents required different kinds of information. However, the most important information that drivers had thought capable of helping them was information on congestion.

4.5. Method 2: Exploratory Interview

A purposive sampling technique was used to select the respondents. The criteria for purposive sampling was based upon respondents' vehicles parked in front of their houses or parked in a garage. The respondents were interviewed in their house for approximately 30-40 minutes. There were 30 participants in total, 20 of whom were male and 10 were female. All respondents held valid driving licences. Age of participants ranged from 31 to 50 years (n =30, M

= 37). Respondents were asked regarding their experience with congestion (e.g. while making commuting trips), new technologies in vehicles and information requirements. At the end of the interview, participants had the opportunity to ask any question to the interviewer (See Appendix 2). While, for governmental and private agencies, investigators interviewed the authority in the agencies, for example, Chief Police Officer of Kuala Lumpur Traffic Police in their headquarters, and Licensing Department Officer for Ministry of Transportation, Kuala Lumpur and Selangor Branch. However, the interviews with government agencies did not bring much information regarding plans to minimise congestion in the urban areas. The interview took place at government/private agencies, e.g. City Hall, Traffic Police and Ministry of Transportation. Interviews with government and private agencies faced several difficulties where some vital information could not be presented because of its confidentiality.

Opinion and Experience toward Congestion

The participants indicated that their driving experiences varied ranging from 9 to 15 year ($\underline{M}$ = 11). The result also showed that 40% of the respondents are annoyed when trapped in congestion that lasted for more than 2 hours. Some of the respondents (27%) mentioned that they sometimes get immune to the heavy jams (that lasted more than 2 hours). The study also found that most of the respondents (57%) agree that congestion, especially from work to home is worse than congestion from home to work. Fifty-seven percent of the respondents also stressed that rain can cause congestion to become worse. This would cause bumper to bumper congestion especially in making home journey.

New Technologies and Information Requirements

Most of the respondents did not know anything regarding new technologies in vehicles, e.g. route guidance (75%) compared to 25% participants who said that they know about the new technologies in vehicles. The sources of information from which participants know about technologies in vehicles were vehicle magazines and foreign pamphlets. In fact, some of the respondents are afraid of new technology. They claimed that the technologies are aimed at substituting human as a driver. The participants would like to have several information such as route guidance, congestion warning information or parking guidance. Other information that they thought were important are rules and regulations; alternative route to avoid congested road and incident detection.

4.6. Method 3: Postal Survey

The participants were selected by employing simple random sampling technique using drivers databases as provided by motoring organisation. Respondents' names were taken randomly using a random table numbers. 500 names were taken as the sampling frame and 100 were selected from that frame. Questionnaires were sent to the 100 potential participants. At the end of the study, 55 respondents participated, where 29 of them were male and 26 were female. Participants age class were ranged from 20 to above 60 years (N = 55). They all held valid driving licences. The survey was carried out in Kuala Lumpur and its surrounding areas in 1995. Before the survey commenced, a schedule had been drawn out. The schedule listed a series of things to do when making postal survey study. The participants received a letter containing a questionnaire (See Appendix 3) and pre-paid postage envelope. Respondents were asked to complete the questionnaire and return it by post. After 1 month, only 20 questionnaires were returned. A reminder card/letter was later sent to the participants. At the end of the study, 55 respondents had returned the questionnaires.

The questionnaire was used to gather and analyze information collected from drivers regarding the aims of the survey. Information from group discussions and exploratory interviews were formed as part of the development of questionnaire. The questions also had been drawn from several past studies which were interested in investigating drivers' information requirements and their working/commuting trips. Questions from relevant literature had been carefully formed in order to ensure its suitability to Malaysian situation. In addition, there were also some relevant studies in Malaysia which asked similar questions, e.g. demographics and working detail aspects. A questionnaire was constructed and it comprised a series of structure tasks to be completed by respondents. The questionnaire used was designed to provide general information on drivers' information requirements such as: (a) information needs, (b) time to present the information, (c) method to present the information.

Congestion Information Requirements

There were 29 male and 26 female drivers who took part in this study. Twenty-one respondents were Malays, 18 were Chinese, 13 were Indian and 3 others of other origins, which refers to Sikh, Kadazan and Eurasian. For home to work trips, the information that drivers would prefer to have when dealing with congestion varied. They would like to have information on alternative route recommendation (41.8%), traffic information (20%), police guidance information (18.2%), location of congestion (16.4%) and reason of congestion (3.6%). Similar to the case of home to work trips, drivers' information requirement for work to home trips also varied. For instance, traffic information was the biggest percentage (39.3%) compared to other types of information. However, respondents also indicated the need for other types of information such as alternative route recommendations (30%) and rules & regulations (19.7%) and route choice information (11%).

Method to present congestion information

In this section, respondents were given several examples of the ITS system, e.g. the suitable method to present the information that they required. Thus, it could be disputed regarding the response or information gathered regarding the issues of the possible method to present the information. It was not known whether participants knew all the possible methods. However, one of the methods included in this survey was commercial radio which is one of the dominant sources of information for the drivers in Kuala Lumpur and its surrounding areas. Thus, it was assumed that respondents knew the system, e.g. commercial radio. However, it needs to be emphasised that the response given by the participants might not reflect their knowledge or attitude towards the possible ITS system. Therefore, their responses may not be reliable regarding the most suitable technique to present the information. However, the information could be used to gather initial knowledge regarding respondents' opinion. Nevertheless, caution should be taken in applying the data to real life situations.

Table 4.1 shows that most of the respondents preferred commercial radio as their possible method to present the information (e.g. in both situations - home to work and vice versa). However, subjects also preferred other types of method, e.g. CB radio, in-vehicle systems and VMS. As mentioned earlier, caution must be applied when generalising the findings to the overall motorists' population. Most of the respondents did not experience of being given information from the above sources. Thus, the opinion was their own subjective estimation regarding the capability of the entire mediums. Consequently, one may dispute these results because it did not represent motorists' experience concerning the entire methods, which could produce different evidence.

Table 4.1. Method to present information for two types of journey

	Home – work trips (%) N = 55	Work - home trips (%) N = 55
Commercial radio	38.2	40
CB radio	30.9	38.2
In-vehicle systems	23.6	12.7
Variable messages signs	7.3	9.1

Time to present congestion information

In this section, respondents were asked regarding when they need the information that they required. The result shows there were variety of timing to present the information. For example, in both home to work and vice versa, drivers preferred to receive the information before the trips than during the trips and in both situations, e.g. before and during the trips. Table 4.2 shows the results of timing to present the information for both home to work and vice versa. However, some of the respondents would like to receive their information during their trips to their destination, e.g. home or work. Indeed, some of the respondents would prefer to have the information in both situations, e.g. before and during the trips.

Table 4.2. Timing to present the information

	Home -work (%) N = 55	Work - home (%) N = 55
Before the trips	43.6	38.2
During the trips	41.8	34.6
Both situations (e.g. before and during the trips)	11	23.6

4.7. Method 4: Interview Survey

Sixty respondents participated in this survey. Several criteria had been used in selecting the potential respondents. For the purpose of the interview survey, a new questionnaire has been developed. In addition, the questionnaire had been developed based upon relevant literature and the results of the postal survey. The interview method was chosen because of the intention of the investigator to know more about the information that drivers require. The study was carried out in Kuala Lumpur in 1996. Four research assistants were employed. A series of training were given to the research assistants. Several aspects of the training such as selecting of respondents, explaining the aims and procedures of the interview, asking the question and answering participants query were given to the research assistants. A pilot study was conducted aiming at encouraging research assistants to make use of their training.

The target populations for the interview survey were drivers, who used their vehicles, e.g. a car or a van to work. In addition, several areas in Kuala Lumpur were chosen as sampling frame in selecting potential respondents. Several criteria were used in order to select the respondents. Firstly, research assistants should see if there were vehicles parked in front or inside the garage of the potential respondents. Secondly, research assistants would ask the owner of the vehicles to take part in the interview, only after they were explained briefly regarding the aims and the procedure of the interview. Thirdly, after getting the respondents' agreement, they were asked several questions such demographic aspect, working detail etc in order to ensure that they matched the criteria of the survey. The respondents were selected by using purposive sampling that used the above criteria.

The interview was based on the questionnaire. It took place in the respondents' own environments, i.e. in their house. The interview took approximately 30-45 minutes per person. At the end of the interview, respondents were given an opportunity to ask research assistants, if they had any queries. The questionnaire (See Appendix 4) consisted 3 sections. The sections were:

Section A: Details about the subjects (demographics aspects)

Section B: Working details and commuting trips

Section C: Driver information needs

General details of the subjects

All of the drivers reported that they drive to work (N=60). 39 male and 21 female were interviewed, which comprised 22 Chinese, 18 Malays, 15 Indians and 5 others which referred to as Eurasian origin. Respondents types of employment could be broken down into several categories, e.g. private sector firms (50%), government sector worker (38.3%) and 7 (11.7%) of the respondents were self-employed businessmen. Their driving experiences also varied. For instance, twenty-seven of the respondents (45%) said that they had 6 to 10 years driving experiences. In addition, 28% of the respondents indicated that they had more than 10 years driving experiences. Finally, 27% of the respondents had 1 to 5 years driving experiences.

Information Requirements

Drivers' require several type of information when making commuting trips. Table 4.3 shows the combined result of information that drivers need for commuting trips, i.e. home to work and work to home. The table clearly shows information that drivers required when making commuting trips. The important finding from the table was the similarity of respondents' information needs even though in different types of journey. For instance, in both trips, respondents indicated that they would like to receive information regarding vehicle status or alternative route. Nevertheless, the percentages of responses varied according to a driver's experience or opinion. As an example, respondents reported that parking information is important in home to work trips as to the work to home trips, the percentage difference was below 5 per cent. This may suggest that there are limited numbers of parking facilities in respondents' workplace. However, it is not a problem when travelling to home where respondents have their own parking spaces, e.g. garage. The results were also consistent with other past studies which mentioned the need of variety types of information (e.g. Streff & Wallace, 1993).

Table 4.3. Drivers' Information Requirements (home to work and vice versa)

	Home - work (%) **N = 60**	Work - home (%) **N = 60**
Parking information	33.3	3.3
Trip planning	20	30
Route guidance	13.3	11.7
Vehicle status	13.3	21.7
Alternative route	11.7	10
Weather	5	5
Congestion	1.7	5
Incident detection	1.7	3.3
Road condition	—	10

The respondents were also asked regarding their information requirements when making unfamiliar trips. The results could be broken down into two categories of drivers, i.e. experienced (i.e. who experienced driving to unfamiliar destinations) and inexperienced drivers (i.e. who claimed that they have never travelled to unfamiliar destinations before). Table 4.4 shows the result on unfamiliar trips information requirements. The result shows that although for the different categories, some similar types of information are also required, i.e. parking information or traffic information. This may suggest the importance of this information in helping drivers to achieve their goals, i.e. arriving at destination. Similar to the commuting trip information requirements, different types of drivers may place different information as important whereas others may regard it as second or third most important in their trips. For instance, experienced drivers indicated that parking information as important whereas inexperienced drivers consider traffic information as the most important for them. It is also consistent with the findings of Haselkorn et al., (1989) who reported that the motorists themselves have different kinds of information requirements.

Table 4.4. Unfamiliar trips information requirements

	Experience drivers (%) N = 27	Inexperienced drivers (%) N = 33
Parking information	14.4	8.3
Route finding	8.3	6.7
Traffic information	8.3	16.7
Alternative route	6.7	—
Route following	7.3	6.7
Trip planning	—	8.3
Road condition	—	8.3

Method of presenting information

Similar in the case of the postal survey, the result regarding the possible method of presenting the information should be applied with caution. It is because drivers have not been exposed to the systems, e.g. in-vehicle information unit, VMS or CB radio. However, some of the respondents do have some experience of being informed by the commercial radio. Nevertheless, the data concerning the best possible method to present the information was merely respondent opinion regarding the systems. Thus, the validity of the information could be argued, as there was no system yet available for the use of drivers.

The study found that drivers prefer commercial radio as an appropriate source to present information that they require in all three driving situations e.g. home to work, work to home and unfamiliar trips (i.e. can be broken into experienced and in-experienced drivers). Table 4.6 shows the results of methods to present information to drivers. The results show in both trips, i.e. home to work and work to home, respondents would prefer commercial radio as the most appropriate method to present the information. In both trips, home to work and vice versa, commercial radio was the predominant method of preference compared to other method. However, some respondents also prefer other type of methods.

Table 4.5 Method to present information (commuting trips)

	Home - work (%) N = 60	Work - home (%) N = 60
Commercial radio	41.7	48.3
CB radio	35	25
In-vehicle system	13.3	16.7
Variable Message Signs	10	10

The result for unfamiliar trips can be divided into two sections, first, dealing with drivers who have some experience driving into unfamiliar areas and second, concentrating upon the result of drivers who claimed that they have never made an unfamiliar trips. Table 4.6 shows the result of the methods to present the information when making unfamiliar trips.

Table 4.6 Method to present information (unfamiliar journey)

	Experienced driver (%) N = 27	Inexperienced driver (%) N = 33
Commercial radio	20	26.7
CB radio	13.3	15
In-vehicle system	5	8.3
Variable Message Signs	6.7	5

The result also shows a similar case as with commuting trips. Both types of drivers, i.e. experienced and inexperienced drivers prefer commercial radio compared to other types of method to present their information needs.

Timing of information to be presented

The findings revealed that respondents would want the information before they are on their way to their destination. The above result applies to home to work, work to home and drivers who have experienced driving to unfamiliar areas. However, drivers who have never made any unfamiliar journey want the information to be presented during the trips, i.e. while on their way to the destination. As mentioned earlier, in both trips, i.e. journey to work and from work, respondents would like to receive the information before they start the journey. For instance, in home to work trips, drivers want the information before the trips compared to during the trips and in both situations, e.g. before and during the trips. Table 4.7 shows the result.

Table 4.7 Timing of information (commuting trips)

	Home – work (%) **N = 60**	Work - home (%) **N = 60**
Before the trip	45	45
During the trip	33.3	31.7
Both situation, e.g. before and during the trip	21.7	23.3

The experienced drivers who made several unfamiliar trips prefers the information to be presented before making the trip compared to during the trip and in both situations. When asking the same question to the drivers who claimed they have never made an unfamiliar trips, the results was that most of them prefer the information be presented during the trips compared to in both situations and before the trip. Table 4.8 shows the result of both categories of drivers regarding the timing to present the information.

Table 4.8 Timing of information (unfamiliar trips)

	Experienced drivers (%) **N = 27**	In-experienced driver (%) **N = 33**
Before the trip	21.7	18.3
During the trip	15	20
Both situations, e.g. before and during the trip	8.3	16.7

Planning trip to unfamiliar destination

This section asks drivers regarding the strategies that they would use for planning a trip to an unfamiliar destination. This result also can be divided into two categories, i.e. experienced and inexperienced drivers. The study shows that experienced respondents would use several strategies. For example, they would go on a trip without planning, ask someone for the route information, make a sketch map of the route, and ask an acquaintance to plan the route. On the other hand, inexperienced respondents would also ask someone for route information, make a sketch to plan a route, make notes to plan a route and use information derived from a motoring organization to plan a route.

Table 4.9 shows the result of strategies that drivers would use when planning trips to unfamiliar environment. The results clearly revealed that variety of strategies are used in order to plan a trip to unfamiliar destination. Indeed, different types of drivers', e.g. in term of driving experience, may use different kinds of strategies. However, one should be cautious in interpreting these results to the overall motorists' population. This is because the small number of participants in this survey may hinder the generalization of the findings to the overall drivers' population.

Table 4.9 Strategies for planning trips in unfamiliar destination

	Experienced drivers (%) N = 27	Inexperienced drivers (%) N = 33
Went without planning	23.3	—
Asked someone for route information	10	25
Made a sketch map of the route	6.7	11.7
Ask an acquaintance to plan the route	5	—
Making a notes to plan the route	—	10
Using motoring organization information	—	8.3

4.8. General Results

Considerable amounts of data were generated from all the methods used in this preliminary study. The purpose of this section is to summarise the key findings (i.e. based upon the aims of the preliminary studies).

- The information that drivers require varies. For instance, different methods employed in the preliminary studies revealed the variety of types of information is needed. In addition, different types of journey also prompted different kinds of information. Furthermore, different categories of drivers (i.e. experience vs. inexperience) also revealed the need for different kinds of information needs.

- Information that drivers require across the studies also varies. They need information such as traffic condition, congestion, parking, route guidance, alternative route, rules & regulations, incident detection, traffic information, police guidance, location of congestion, reason of congestion, route choice, trip planning, vehicle status, weather, road condition and route following.

- The respondents prefer commercial radio as the best medium to present the information compared to other types of medium of presenting information. The possible timing to present the information also varied. Some of the respondents would like to receive information before the trips. Others would prefer to be given information during their trips. Furthermore, some would like to have the information in both situations, e.g. before and during their trips.

- Strategies that drivers would use to plan their unfamiliar journey varied as well according to their categories. For experienced drivers, they would go without any preparation, ask someone for the route, make a sketch map of the route or asking an acquaintance to plan the route to their destination. Whereas, the inexperienced drivers would ask someone for route information, make a sketch to plan the route, make notes to plan the route or/and using motoring organization information.

- However, all the responses were purely subjective or based upon the respondents' opinion, without any facts/evidents to support this finding. In addition, it could not be used in generalising the findings to the overall motorists' population. Moreover, the subjective preferences may not reflect the true capability of the systems, which need to be investigated further.

In conclusion, the study clearly shows that the use of different methods in the preliminary studies resulted in different findings. However, some of the information seems to complement each other. The preliminary studies were one of the steps towards the main study which is described in the next chapter (Chapter 5).

4.9. Discussion of the result

The results clearly show that different techniques used in the preliminary studies revealed different kinds of information that drivers require. The findings also show that drivers for different types of journey also required different kinds of information. The result from all the techniques used suggested that there is variety of types of information that drivers would require in order to assist in their driving task. The information varies according to the trip types and drivers categories. For example, in the focus group method, respondents mentioned the need for congestion information.

This kind of information was also needed in other surveys, e.g. postal and interviews survey. This may suggest the importance of congestion information to drivers. Indeed, congestion messages may comprise several elements such as the place of occurrence (i.e. location), the predicted duration (i.e. timing) and reason for congestion (i.e. causes of congestion). Therefore, the driver's perceive information such as congestion may help them while making certain trips, e.g. commuting trips

Although there are differences regarding the information that drivers require across the studies, there are also some similarities in terms of the information that they require. For example in the interview survey, although in different types of trips (i.e. home to work and work to home) respondents still listed the same types of information. This might suggest that they actually rated the information as the most important. However, one could argue this because the nature of the information that a driver requires may not be suitable to be presented to all drivers.

Some of the information that drivers require also have its significance in influencing the condition of traffic. For instance, parking services information is vital to the drivers. Information offered could be used as guidance for the motorists to park their vehicles in the CBD (Central Business District) in Kuala Lumpur and other areas. Information such as parking fees, time duration, location and spaces of parking that are offered in the parking services might be used by the motorists. It is because the number of parking spaces in Kuala Lumpur and its surrounding areas have been reduced by the City Hall and local municipal government in order to minimize congestion and the growing numbers of vehicles entering CBD and other areas (e.g. City Hall, 1992). In addition, by providing information concerning parking places could reduce the amount of time that drivers would spent for searching the available parking facilities (e.g. Axhausen et al., 1994).

Apart from parking guidance, route guidance and alternative route recommendations were also considered important in three types of trips, i.e. home to work, work to home and unfamiliar trips. The route guidance information could help drivers in several aspects including the ability to find the best possible route in order to avoid congestion to help drivers while travelling to unfamiliar environments. Information such as landmark, street names could be offered within this information that could help drivers to maintain their course of driving to their destination. However, several factors could influenced driver's decision to use route guidance information in order to search for the best route to take. Factors such as driving experience, route choice criteria and gender might affect driver's decision to use other routes (e.g. Khattak et al, 1993).

The study revealed that drivers require different kinds of information for different type of trip purposes, e.g. commuting trips. Thus, different kinds of information required by the drivers suggest that drivers' population could not be treated as a homogenous population which have the same needs. However, based upon the results of the above studies, most of the information required was based upon their experiences and the significance of information to the drivers. Nevertheless, other studies also revealed different requirements of information among motorists (e.g. Penttinen et al., 1996).

Indeed, when categorizing drivers based on their driving experience (i.e. whether they have been driving to unfamiliar destination or not), their information needs also differ. This could suggest that experience do play a vital role in determining information requirement. This finding might be consistent with previous works by Haselkorn et al (1989) and Tsai (1991) which found drivers could not be classified as having the same information requirements. However, this conclusion could be argued because of the nature of the data, which limited the generalization of the findings to the real life situation.

Most of the drivers indicate commercial radio as the appropriate medium to present the information that they require compared to other methods such as in-vehicle information system and variable message signs. Based upon their experiences of being exposed to the information presented by the commercial radio, they most likely would use or want to use commercial radio stations. Past studies also revealed the advantages of commercial radio in presenting information, i.e. helpful (e.g. Wallace & Streff, 1993). However, past studies also revealed the negative side of commercial radio in presenting information that drivers required. For instance, the information is not relevant and it is received too late (e.g. Wallace & Streff, 1993). In addition, some of the information conveyed is too general, which may not represent the actual nature of traffic information and did not help drivers. The study also found that respondents also would like to receive information from other types of method such as CB radio, VMS and in-vehicle. However, the response should be treated with caution because the above systems are not yet available in Malaysia. Thus, drivers did not know the capability/performance of these systems. Therefore, their response was purely subjective opinion regarding their preference of method to be presented the information that are required.

In addition, there was no agreement regarding the possible timing to present the information that drivers required. For instance, most of the drivers want the information to be presented to them before they start their journey. This suggests that by giving the information to the targeted subjects far in advance could help them in making accurate decision. However, some larger fractions of the respondents also indicate that they want the information to be given during their journey. This may suggest that they could also change their decision while en route to their destination. No universal agreement regarding timing to present the information could also suggest that some information should be presented early compared to other information. The information that should be presented early is to influence a driver's decision of their next action.

In addition, when categorising drivers according to their driving experience (i.e. experience in travelling to unfamiliar destination), the timing to present the information also varied. This may suggest that driving experience may influence the timing of the information to be given. Thus, it may suggest that the systems designers should also consider driving experience factor when presenting the information to drivers.

The implication from the study is that drivers require variety of types of information. In addition, different types of journey may influence the need for different kinds of information. Furthermore, different driver's category, i.e. in term of driving experience may also affect different information requirements. This issue needs to be addressed thoroughly by systems designers before developing the systems. The findings clearly support evidence of past studies, e.g. Haselkorn et al., (1989), Tsai (1991), Streff & Wallace (1993) and Penttinen et al., (1996) which found different information requirements by different kinds of drivers, e.g. commuters, dispatchers and others. Indeed, past studies also revealed that in different types of journey purposes also influence the requirements of different kinds of information (e.g. Penttinen et al, 1996).

Drivers would employ a variety types of strategies in order to plan their unfamiliar journey. For example, some drivers would ask someone for the route information. This information could be used as a guidance in searching for their unfamiliar destination. However, the person supplying the information may not be the suitable person to give the information. Thus, they may get lost. In addition, people commonly give vague or incorrect direction, which may affect a driver's decision. Nevertheless, Streeter et al (1985) found that drivers using tape-recorded instructions made the least amount of error and could reached the destination in the least amount of time. This may suggest that this strategy could assist driver in arriving at their unfamiliar destination.

In addition, some drivers also prefer to go without any preparation. This unrealistic view of their driving behaviour may be costly, e.g. could lead to accidents (e.g. Engels & Dellen, 1986). It is because they did not have information appropriate for the activities. However, Schraagen (1990) argued that drivers who employed this strategy, e.g. went without planning, have general knowledge about road types in their unfamiliar destination. This knowledge could help them in searching or arriving at their destination. Indeed, Gordon & Wood (1970) also found that some drivers may use this kind of strategy e.g. went without planning, as their main strategy rather than to remember an entire route of five or more unfamiliar choice points.

Other strategies that drivers would use including making notes and sketch out the destination route which could help drivers in reaching their destination. In addition, some of the respondents also listed the help from acquaintance to do the planning. Thus, by getting information from an experienced person may help drivers. For example, acquaintance can provide specific roadside details that could serve as landmark cues in reaching their unfamiliar destinations. However, this finding is new in Malaysia where there is no reported study or available material concerning the issue is yet available. Thus, one may argue the significance of the evidents revealed in the studies. Nevertheless, the study could serve as a guideline in term of local context since there is no available study to date so far. However, the study clearly shows that different kind of drivers may use different kinds of strategies in order to arrive at their destination.

Yet, the study was in fact exploratory in nature which should be treated with caution. Therefore, there is a need to conduct more studies regarding drivers' information requirements. However, the information that has been collected in these could guide researcher in developing the main instruments for the main study, i.e. interview survey and experimental works.

4.10. Methodology Issues

The preliminary study employed four types of methods in order to collect data regarding drivers' information requirements. This section will discuss the significance of using all methods in preliminary study.

Focus group discussion

Focus group is suitable in exploring the nature of the problem because researchers could interact directly with respondents. It also provides an opportunity to obtain a large and rich amounts of data (Stewart & Shamdasani, 1990). This approach was conducted with the aims to explore drivers in Kuala Lumpur, especially commuters, regarding several new issues to them, e.g. information needs and new technologies in vehicles. The information collected was exploratory and could help investigator to develop more precise understanding of the issues being studied. The method could be used as a guideline to develop other instruments, e.g. questionnaire. Thus, information gathered from this approach would provide several insights into the complexities of the different major orientations. It would also provide ways in which those complexities could be tapped in a more structured and appropriate method to be administered to a much larger sample and variety of aspects to be covered (Krueger, 1988).

It is evident that the above assumptions can be criticised. For example, this method seldom provides satisfactory answers to research questions. It is because the responses or information collected are not suitable to the aims of the study. For example, respondents do not want to give the accurate answer regarding certain issues. In addition, the method also suffers drawbacks in term of the issue of representatives. In this study, the respondents were not representative of the actual target population. It is because the respondents were selected on the basis of relevancy to the topic understudy. Thus, the information collected should be treated with caution in interpreting the findings and generalising the result to a representative population, i.e. motorists' population.

The information gathered regarding participants' knowledge about new technologies in vehicle and drivers' information needs would not necessarily yield a precise and accurate picture of drivers' opinion/responses. However, the information could bring other advantages, for instance, it could suggest what the results of a more careful study might be. In spite of that, some of the information were relevant, e.g. participants' experience involving with congestion (e.g. Dewan Masyarakat, 1992). The information might help investigator to learn more about drivers' experience and opinion concerning congestion during rush hour which had not been reported or investigated so far in Malaysia.

Another drawback of this approach was that sometimes the investigator felt uncertain about the accuracy and validity of the responses revealed by the respondents regarding the issues. It is because drivers were given only little information regarding several aspects such as pamphlets concerning information systems. Thus, there was no way researcher could measure drivers' performance regarding the use of information systems. Moreover, some of the participants were not familiar with the new technology in vehicle. Thus, it could hinder the collection of relevant and accurate information regarding drivers' information requirements. However, the information given was used as a guideline in investigating drivers' information requirements.

Related to the above issues, Krueger (1988) argued that the information collected by using focus group discussion could have high face validity. However, the information sometimes did not represent the actual response especially in the real life situation. In addition, a majority of the response/information assembled in this study was qualitative rather than quantitative information which were difficult to analyse, i.e. difficult to make statistical inference because the information given by the respondents was only their verbal report (e.g. Krueger, 1988).

Another problem is that investigator never knew whether their response or interaction would mirror their actual behaviour. Their response was not based upon their own feeling. In addition, Fern (1982) has shown that group discussions do not produce significantly more or better ideas than individual interviews. Other limitation concerning the technique is that the respondents could only offer their verbal behaviour and not their action behaviour. For instance, some of the responses uttered by respondents were in fact only stated preference compared to their revealed response which was based upon their own experience. Although some of the responses were respondents' own experience, e.g. experience in congestion, yet there were no studies which could be used as a guideline or to make comparison. Furthermore, other issues; e.g., plan/method to minimise congestion was simply an opinion that lacks facts to support drivers' claims.

Exploratory interview

The approach had been chosen with the aims to offer the respondents an opportunity to expand their answer, to express feelings, motives or behaviour spontaneously (Campbell, 1950). The purpose of this exploratory interview was to develop ideas and research hypotheses rather than to gather facts and statistics (Oppenheim, 1992). The investigator intends to understand how ordinary people think and feel about the topics of concern to the research. The use of this approach was useful especially when probing information regarding drivers' information requirements and other issues. Indeed, the method was proven helpful in producing more selfrevelations by the respondents (e.g. Dohrenwend, 1965) and produce fuller and 'deeper' replies (e.g. Bradburn, 1983).

There are several points upon which the method can be criticised. For example in this study, limited numbers of drivers participated in the interview. The respondents were selected by using non-probability-sampling technique, which restricted equal number of respondents to be included as participants in the study. This in turn would affect the generalisation of the findings. Thus, the result gathered from this interview might be questionable because of small number of respondents. In addition, the information which drivers required could only apply to the participants who participated in the interview.

Another problem related to the above issue is interviewer bias which could influence the information given by the respondents. Although, interviewers were given training, there was no follow up measure regarding the interviewer's performance or the quality of the interview process. Nevertheless, the training given to the interviewer was assumed able to minimise interviewer bias in order to gather only relevant and vital information regarding drivers' information requirements.

The use of open-ended questions was proven to be very demanding. It is because it required more effort from the respondents, e.g., asking them to give full detail information. The respondents may feel bored or tired when they were asked with too many questions. As a result, some of the respondents did not answer or skip some of the questions during the interview. Nevertheless, the interviewers were given training in motivating respondents during the interview in order to minimise their boredom or tiredness.

Indeed, some of the respondents gave good and vital information regarding the aims of the study, e.g. information requirements. Although, the use of open-ended questions tend to elicit higher level of reporting by respondents (e.g. Sudman & Bradburn, 1974), it also has some problems, e.g. respondents not answering certain questions. In addition, some of the information given by the respondents may be unreliable and difficult to codes/quantify.

Postal survey

This approach were used by many researchers especially when investigating a large numbers of sample, e.g., drivers study (i.e., Rothe, et al. 1990; Bishu, Foster & McCoy, 1991; Mannering, et al. 1995). The use of postal survey has its significance in terms of distributing questionnaire to a large numbers of respondents. It was hoped that by distributing questionnaire to a large numbers of respondents, rich amounts of data could be collected. Postal survey has other advantages such as it can be done relatively quickly. The problem of interviewer bias could be avoided due to the self-administered approach (e.g. Babbie, 1992).

The following points proved the disadvantage of the method employed in the preliminary studies. For example, there was the non-response problem in which it could hinder the possibility of collecting relevant and useful data. Related to the above issues, postal survey never produces the satisfactory good response rates. In addition, the major factor leading to a response bias in postal survey is generally the low response rate. In turn, low response rates necessarily produce smaller sample. The problem is that low response rates make it likely that the resultant sample is biased (e.g. Shaughnessy & Zechmeister, 1990). However, one may argue that response rate in this postal survey was quite good (55%) compared to the average postal survey response rate, e.g. maximum 30% (e.g. Williamson, et al. 1982). Nevertheless, some of the responses given by the respondents were inadequate, i.e. some of them did not finish the questionnaire or only responded on certain question such as demographic aspects.

Thus, this non-response could contribute to the biases of the result produced from the postal survey. Hence, it limits the number of useful questionnaires to be analysed. In addition, the researcher did not know whether respondents understood several terms used in the questionnaire, such as route guidance. Furthermore, the respondents who were selected to participate had low degree of enthusiasm and involvement to respond to the survey. This may hinder the progress of the data collection. The researcher, for example, did not have total control regarding the issue of who actually answered the questionnaire. Therefore, the responses given by the participants might be questionable - in term of its reliability or validity.

Although, the respondents had been selected by using simple random sampling approach, there is one question arose regarding the generalisation of the findings to the overall drivers' population. For example, the survey only covers small number of participants. In addition, the list of drivers that were used as a pool to choose potential respondents were inadequate compared with the Road Transport Departments drivers' databases.

Thus, the results should be treated carefully when trying to generalise to the population of motorists' in Malaysia. However, some of the responses clearly related or supported the findings from earlier studies, e.g. focus group and exploratory interview. In conclusion, the use of postal survey was effective in gathering useful information regarding information requirements. The information collected helped in enhancing researchers knowledge regarding Malaysian drivers' information requirements.

Interview survey

The questionnaire was developed based upon the information collected from the focus group, exploratory interview, postal survey and relevant literature. There are a number of advantages in having a questionnaire administered by an interviewer rather than the respondents. For example, interview survey could attain higher response rates than postal survey. In addition, within the context of the questionnaire, the presence of an interviewer generally decreases the number of "don't knows" and "no answers". Furthermore, the interviewer can observe as well as ask questions.

However, the interview survey method used in the study could be criticised. For example, the potential for interviewer biases. This interview bias occurs when the interviewer tries to adjust the wording of a question to "fit" the respondent or records only selected portions of the respondents' answers. However, it was assumed that the training that had been given to interviewers could reduce the interview bias. In the training, interviewers were asked to abide to the training guidelines in order to minimise the interview bias, e.g. rewording the questions. In addition, the information collected from 100 respondents' participants could not assumed to represent the overall motorists' population in Malaysia. In fact, they were selected by using purposive sampling which did not represent drivers in general. Furthermore, there was no guarantee that the interview conducted was of good quality as there was no survey director present to help or assess interviewers' performance.

Although, the method could attract and collect more data from respondents compared to other approaches employed in preliminary studies, it has some negative impacts. For example, some of the respondents in this study did not quite understand about several terms used in this study such as route guidance systems or in-vehicle information systems. Even if the research assistants explained to them, there was no indication on whether the respondents understood the explanations given by the interviewers. This could impede the interview in terms of collecting the necessary information regarding drivers' information requirements.

Nevertheless, the preliminary interview survey was useful in developing some questions regarding several aspects such as the training that should be given to the interviewers and information on aims of the study. It also gave the researcher an insight into more information regarding drivers' information needs and helping in designing the appropriate plan for the main study, e.g. interview survey and experimental works. Thus, for the main study, it was decided that the interview survey would be used as the main approach for collecting information on several issues such as information needs. Based upon the result of preliminary studies, the interview survey was chosen because it could produce reasonable response rates compared to other methods, e.g. postal survey.

However, one may argue that postal survey also produces satisfactory response rate similar to interview survey. In spite of that, the use of postal survey does not guarantee the right person actually completed the questionnaire compared to interview survey in which respondents have to answer the questionnaire in the presence of interviewers. In addition, several terms or unfamiliar terms e.g. VMS, route guidance or RDS-TMC need to be revealed and explained to respondents during the interview compared to postal survey which may hinder respondents understanding/comprehension concerning the terms. Thus, based upon the these reasons, the interview survey was selected as the main method for the main survey.

All of the methods used in the preliminary stage offered some useful information regarding the availability of sampling method to choose, potential respondents, sample of reference to use, new information or aspects that need to be investigated further in Malaysia as there was no study reported so far regarding among others, route planning and wayfinding. In addition, all of the methods employed in this study served as a guideline to design and develop instrument for the use of major study i.e. interview survey (Chapter 5).

4.11. Chapter Conclusion

This chapter reports the results of preliminary studies with drivers in Kuala Lumpur and its surrounding areas. The usage of many approaches in the preliminary study was to gain some knowledge regarding the suitable method to be used in the main study. In addition, the use of several methods in this study was also part of a plan to investigate thoroughly the issue of driver information requirements. It is also to gain some comments regarding the suitable methods to be used in the major study. From the above methods, an interview survey was chosen to be used in the main survey because of the need of having the right person to answer the questions. In addition, the need to explain certain technical terms was one of the reasons of employing interview survey.

The preliminary study found that respondents reports that they require different kind of information for different types of journey purposes, e.g. commuting and unfamiliar trips. This study was preliminary and exploratory; therefore, the results were not conclusive. However, this information gave some insight and background for designing the survey for the main study which was described in Chapter 5. The next chapter introduces research investigating commuters' information requirements in greater depth and through a larger sample.

Chapter 5: Main Interview Survey

5.1. Chapter Summary

This chapter provides the rationale for conducting another study regarding drivers information requirements. The chapter also describes the survey methodology, i.e. survey sampling, survey administration and analysis. The results are presented in Chapter 6 and discussed in Chapter 7.

5.2. Introduction

Some of the problems regarding the information that driver requires were identified in the preliminary studies in Chapter 4. However, more study is needed to establish the nature and extent of these problems. Thus, a main study regarding drivers information requirements was necessary. A more detailed account concerning the commuters trips information requirements, route choice, wayfinding and route planning was also essential. The aim was to gain more knowledge regarding these aspects as no study had been reported so far about those issues, e.g. information requirements especially in the local scenario.

Thus, a major interview survey was chosen because of limited information gathered from the preliminary studies. Indeed, the literature produced an abundance of information, however, this did not indicate that their findings should be consistent with local studies. It is because of the different context and the way the topics were examined. As mentioned earlier, there was no reported study so far regarding several issues in this thesis, thus the information gathered from the major study might be different compared to the literature review.

Thus, another in-depth study was needed in order to collect more relevant information concerning local drivers' information requirements. The in-depth and larger sample of the study were needed in order to generalise the findings to the overall commuters' population. Whereas preliminary studies were only for the purpose of collecting variety of information in order to develop the plan for the main study. Hence, the use of various types of methods in the preliminary studies served the purposes of gathering numerous kind of information concerning information requirements.

The use of survey is the most common approach reported in the literature to investigate the problems concerning drivers' information requirements. These surveys use different methods to answer a range of research questions. The main study employed interview survey based upon the findings in the preliminary studies. The preliminary studies showed the advantages of using interview survey compared to the other types of approaches, e.g. postal survey or focus group discussion. Nevertheless, the needs to avoid non-response rate and to explain several technical terms to respondents were among of the reasons, investigators choose the interview survey as the main method for the study.

5.3. Aims of the survey

From the perspective of the thesis, the primary aim of this study was to identify drivers' information requirements for different types of journey. In addition, the study also aimed to find out based upon drivers' opinion, regarding the possible method to present the information and the appropriate timing of presenting the information. Furthermore, the study also sought to examine how local drivers currently navigate. This referred to the use of strategies in several unfamiliar environments. Navigation refers to both wayfinding and route/journey planning strategies in travelling to unfamiliar environments. Finally, the survey aimed to explore how local drivers choose a route. This refers to the route choice criteria that driver used when selecting a route for several types of journey.

5.4. Questionnaire design

This section explains how the questionnaire was developed. Based upon the results gathered from the preliminary studies and relevant literature, a questionnaire was developed. The questionnaire was used to collect data regarding the aims of the study. The content was based on the specific information needs of this study, an extensive review of a similar survey and suggestions from various people regarding the issues of motorists' information needs.

In designing the questionnaire, several factors needed to be addressed so that the survey would gather only relevant data. For example, the problems that needed to be tackled by the survey were regarding the investigation of traffic information requirements of drivers travelling to and from work in Kuala Lumpur, Malaysia. It also tackled the issues of timing and method to present the information. In addition, issues of navigation strategies and route choice criteria were also explored. Thus, the questions that need to be asked to the target respondents, i.e. drivers were related to the above issues or problem, i.e. drivers' information needs and others mentioned in the above.

The question to be asked aimed only at those likely to be able to answer them accurately. Thus, it is reasonable to ask questions regarding drivers' information needs to motorists, i.e. commuters because they drive every day to their destinations. Hence, the problems or issues that investigator was interested to examine in this study were relevant to the drivers. Indeed, the preliminary studies had shown that on various issues, respondents gave some accurate responses.

In this survey, respondents were also asked regarding methods and timing to present the information. This question was asked in order to get their opinion (i.e. subjective opinion). For this section, an example had been produced to enable respondents to answer the question regarding the issues of timing and method to present the information. One may argue the suitability and effectiveness of this technique. However, it is hoped that by showing an example, respondents could relate to the question and give their best response. Thus, it is due to their subjective opinion that the investigator had to be cautious in interpreting the answers regarding several issues, i.e. method and timing.

Several approaches were used in designing the questions and determining the question wordings which includes

- The investigator had searched relevant literature review concerning information requirements. This was to make sure what kind of questions that had already been asked on those issues.

- In addition, the results of the preliminary studies also helped the investigator in determining the questions for use in the survey.

- Furthermore, opinions from several people (i.e. those who have good knowledge on this issues) were also used in designing the questions.

After numerous questions were designed by using all possible approaches, the questions were grouped into several categories:

(a) general information,

(b) characteristics of the respondents and the commute itself (i.e. demographics, driving experience, working details and commuting trips),

(c) traffic information requirements, which also comprised timing and method to present the information,

(d) route choice criteria, and

(e) navigation strategies, i.e. route planning and wayfinding strategies.

Through a series of discussions with relevant individuals, i.e. transportation departments and other researchers, a pilot study of 60 drivers were conducted, and elimination of numerous questions, the final questionnaire was formulated (See Appendix 5). In addition, the result from the pilot study also helped the investigator to be more accurate in determining the question wordings. For example, responses were based on the respondents' experience on what kind of information that they need while travelling to and from work. It is because it is better to refer to respondents' personal experiences rather than in general terms (Moser & Kalton, 1993).

In addition, the pilot study also helped the investigator regarding the language to be used in the survey. Based upon the pilot study, interviewers had to use two languages, i.e. Bahasa Malaysia and English. It is because the specific terms such as route guidance and VMS were best explained in English rather than in Bahasa Malaysia. Indeed, the use of examples had helped both the interviewer and respondents to understand the specific terms used in the survey. Thus, the interviewer had been trained to clarify the meaning of the specific terms accurately and show them some examples regarding the term.

The pilot study and interviewer training were used in determining the question wordings. Ambiguous questions were discarded. It is because different respondents would understand the question differently and would affect the answers given. Thus, based upon the results gathered from the pilot study, the questions were re-developed in order to collect only relevant data concerning motorists' information requirements.

Both issues, i.e. question and question wordings were related to each other. It was because firstly the investigator had to decide what kind of questions to be asked to the targeted subjects. Secondly, the researcher had to determine how to ask the questions. Thus, we could conclude that the questions to be asked or devised by researchers were also related to how they would be asked. In this survey, two types of questions were used; Open-ended and closed-ended. The two types of questions used were based upon relevant review of similar surveys on motorists' information requirements. Indeed, some of the questions used in the survey have been used in Malaysia, to examine several issues such as driving experience and commuting trips. Hence, based upon the literature and the results of pilot study, several types of questions were used in order to gather only relevant data concerning the interest of the study.

Before the final questionnaire was developed, the investigator had to make accurate decision regarding the question used in the survey. For example, the types of the questions used must be accurate as to reflect the need of the study. It was to avoid biased questions and variability in meanings of the question. In addition, the researcher had to decide the sequential order of the questions. This is because the arrangement may affect the refusal rate and it may also influence the answer obtained (e.g. Whitfield, 1950).

Thus, the pilot study had helped the investigator in determining the question's sequential order in the questionnaire. Basically, interesting questions were put in front in order to stimulate respondents' willingness and motivate them to participate further in the survey. Then followed by other topics covering only relevant aspects to respondents. Indeed, interviewers' training comprised tasks on motivating and explaining in detail the purpose of the survey which could help respondents to take part in the study.

The investigator had adopted other researchers' approaches in determining the order of the question. For example, the sequence of questions should lead the respondents meaningfully through the process of exploration. The investigator had followed this aspect in developing the questionnaire and determining the questions. More demanding questions such as information requirements and others were placed later in the questionnaire when respondents' commitment could be presumed to have peaked and fatigue had not yet set in. However, this procedure also has its risk depending upon the motivation of respondents.

The study employed interview technique which uses questionnaire as a method to seek information regarding driver information requirements. It was divided into 9 sections labelled: *general information*, *driving experience*, *working details*, *commuting trips*, *information requirements*, *drivers route choice*, *planning unfamiliar journey*, *finding your way while driving* and *details about drivers*. In order to achieve the primary aims, several approaches were used. For example:

- A specific and direct question was asked regarding the perceived importance of different types of traffic information, that is, "... what kind of information would a driver requires when making a commuting trip from home to work? Respondents were asked to rank them in order of preference (i.e. 1st - most important to 5th - least important). Based upon previous works, different kinds of trips may trigger different kinds of environments. Thus, respondents were asked this question in relation to travelling on several fundamentally different trip purposes or situations: when dealing with congestion, when deciding whether or not to divert to alternative route and when making unfamiliar journey.

- A specific and direct question was also asked, regarding navigation strategies that respondents would use in several unfamiliar situations (e.g. cities, highway and road), that is "...how would you plan your trips to unfamiliar cities? A total of 9 strategies were devised in order to get the relevant strategies that drivers would used while making navigation activities, i.e. wayfinding and route planning.

- A specific and direct question again was asked concerning route choice criteria that drivers use in selecting a route for several types of journey purposes: home to work, work to home and unfamiliar journey. A total of 13 criteria were taken from previous works. The pilot study shows that some local driver actually used them in selecting certain route to their destination. Although both navigation strategies and route choice criteria study was new to local investigator and driver, this study certainly would enrich the knowledge regarding the above issues.

- Finally, an indirect, context-driven question was asked. This involved showing respondents some examples of method and timing to present the information based on their own opinion. The timings and methods were based upon the situations mentioned in the earlier section of information requirements. However, caution should be applied when trying to generalise the findings to overall motorists population. It is because the response may not represent the whole target population.

The questionnaire was divided into 9 sections. The remainder of this section describes its contents.

General Information

The first section of the questionnaire focuses on several aspects such as areas or counties of interview questions on whether respondents drive to and from work, frequency of driving to and from work, and place of residency and work. There are 5 questions in the first section which were asked to all respondents in order to make sure that they match the criteria of selecting participants for the survey.

Driving Experience

This section deals with respondents' driving experience. Questions were asked with the aims to measure: (a) respondent's age at the time of getting the driving licence, (b) years of having full driving licence, (c) years of driving regularly, and (d) frequency of driving to and from work (in term of days).

Working Details

Questions in this section were aimed to investigate several aspects such as respondents' type of employment (i.e. government or private sector), working hours (i.e. start and finish work), distance between home and work, travel time taken from home and work. The final question was interested in examining respondents' flexibility in time when they commute to and from work. This question was based upon Caplice et al., study (1992). This question may give insights concerning the use of time by motorists.

Commuting Trips

This section investigates: (a) route to and from work; (b) knowledge regarding alternative route (i.e. other route that they could take to and from work); (c) how many alternative routes do they know; (d) if respondents ever use these alternative; (e) reason of using the alternative; (f) reason for not knowing alternative route; (g) advantages of using alternative route; (h) disadvantages of alternative route; (i) reason for not using alternative route; (j) advantages of not using alternative route; and (k) disadvantages of not using alternative route.

In this section respondents were asked regarding several aspects of their commuting trips, i.e. regarding the importance of their commuting trips. Respondents were asked regarding the : (a) importance of saving commuting time, (b) importance of reducing commuting distance, (c) importance of increasing commuting safety, and (d) importance of increasing commuting enjoyments. These questions were based on Spyridakis et al., (1991) study which were interested in examining drivers' perception toward their commuting activities.

Respondents also were asked concerning their willingness to change route while commuting. In addition, a question was asked on reasons of respondents' willingness to change route while commuting. The information could give some useful insights regarding drivers commuting trips and their diversion behaviour.

Information Requirements

This section is the largest. Respondents were asked to indicate the information they would like to receive for several types of journey, e.g. commuting trips. They were asked to rank the information according to its importance from 1st to 5th based on their preferences. In addition, this section also asks respondents regarding the possible method to present their information and the appropriate timing to present the information.

Route Choice Criteria

Drivers were asked about the criteria that affect their selection of route for several types of journey, e.g. commuting trips. The criteria were based upon the work of other researchers, e.g. Bovy & Stern (1990) and Benshoof (1970). Respondents were asked to rank the route choice criteria according to five point scale (1 = Very Important to 5 = Not At All Important).

Journey/Route Planning

This section contains questions concerning route/journey planning. Respondents were asked to describe their planning strategies in advance before travelling to three types of unfamiliar destination, i.e. cities, highway and road. There were eight pre-coded options provided. These options were derived from strategies identified and used by Mark & McGranaghan (1988).

Wayfinding

This section emphasises wayfinding methods or strategies that drivers would employ when making several unfamiliar trips. There were three main questions forwarded to respondents to indicate their wayfinding strategies when making trips to unfamiliar cities, highway and road. There were also eight pre-coded options provided. There was also space provided for other strategies not listed.

Demographics

The final section serves to collect additional demographics information. Respondents were asked to indicate their age, gender, ethnic, employer and level of education. These questions were asked in order to get an insight about drivers' information requirements.

5.5. Method

5.5.1. Subjects

There are three factors influencing the decision to sample (e.g. Black & Champion, 1976). These important factors which includes the size of the population, the cost of obtaining the elements and the convenience and accessibility of the elements.

The number of respondents participated in this survey should be larger. However, the investigator does not have knowledge regarding the actual size of commuters' population in Kuala Lumpur. It is because there were no study reported or investigated on the above issues. Thus, based upon investigator's assumption, 1000 respondents would be sufficient in order to draw conclusion from the study. The target population for the survey was commuters who travel from home to work every morning using vehicles i.e. cars, van, etc, as their means of transportation.

First, a contact was made with the Malaysian Department of Transport in order to use the drivers' database as a method to select potential respondents for the survey. However, the departments had a policy which does not allow others to use their databases. Consequently, another method was devised i.e. selecting respondents based upon their areas of residence i.e. district or counties in Kuala Lumpur and its surrounding areas with the use of several criteria.

It was decided that the investigator should use non-probability sampling technique, i.e. purposive sampling to choose potential respondents. In this technique, investigator exercises his judgement to include elements that are presumed to be typical of a given population about which he seeks information. Therefore, the investigator had drawn out several criteria which were used as a format of selecting respondents. The criteria were:

- age
- ethnic group
- commuters (i.e. commute to and from work)
- use vehicles as a means of transportation
- possess a valid driving licence

Based upon the above criteria, potential respondents were selected in 6 districts/counties in Kuala Lumpur and its surrounding areas. The sampling technique, i.e. purposive sampling was employed because it was less and more readily accessible to the investigator compared to the other types of sampling approach. As mentioned earlier, the target number of respondents in this survey was 1000. However, at the end of the interview, only 604 respondents participated. Thus, it might represent only 60.4% of commuters in 6 districts. Nevertheless, one may argue because there was no reported study or reliable sources of number of commuters, which could be used as guidelines. The respondents were interviewed in six districts as follow:

- Kuala Lumpur city centre
- Bandar Baru Bangi/Kajang/Serdang
- Cheras/Sg. Besi
- Gombak/Dato Keramat/Ampang
- Petaling Jaya/Subang Jaya/Shah Alam
- Damansara/Kepong

5.5.2. Survey Administration

The investigator employed six research assistants. Their task was to interview potential respondents. The research assistants were given training which comprised several aspects such as the presentation of the nature and purpose of the survey, the identification of types of questions and instructions, working in the field, e.g. preparing materials, answering respondents questions, reviewing the completed interviews and reporting to researchers and supervisor and other aspects of training that related to the interview survey procedures.

The training was aimed at motivating and exposing all interviewers to the real interview situation. After the training, they were given a task, i.e. to conduct pilot study with the aim to test the appropriateness of the questionnaire to be used in the actual survey. This pilot study was conducted in Cheras with 60 drivers. From 60 drivers, 39 interviews were considered as a complete interview. Based upon the results of the pilot study, several revisions were made on the questionnaires. Changes were made to questions that had confused or misled the respondents. Some of the pre-coded response options were removed and some of them were revised based upon the participants' responses in the pilot study.

The six interviewers were asked to cover six districts in Kuala Lumpur and its surrounding areas in order to conduct the interview. The purposive sampling based upon several criteria was used to select potential respondents. The interviews were conducted on weekends because most of the potential respondents were at home. Thus, it was easy to conduct the survey.

The interviewers went to the potential respondents' houses. The interview procedure was simple, for example:

- Firstly, interviewers would introduce themselves and begin to explain their purposes of conducting the interviews. Secondly, the interviewers would seek respondent's agreement to participate in the interview. If respondents agree, interviewers would again explain in brief the nature, objective and administration of the interview

- Before the interview starts, several basic questions are asked regarding the criteria of the sample selection. The criterion used in making selection of respondents is used. It is to make sure that the respondents are suitable to be included in the survey. The interviewers would have to find another respondents if the respondents do not match the criteria set up for the interview.

- The interviews begin when respondents match up with the criteria used in the survey. Interviewers will ask the questions based upon the questionnaire used in the study.

- Interviewers are asked to attain uniformity in the asking of questions and recording of answers. Interviewers are expected to ask the entire applicable question and to make no unauthorised variations in the wording. However, the interviewing uniformity itself varies with the type of questions. Thus, interviewers were also trained to assess the adequacy of the responses and if necessary, to probe for further details. Indeed, in their training, interviewers are asked to allow a brief expectant pause or relax in order to elicit further information.

- The interviewers are given several schedules in order to make sure that they understand their task. For example, interviewers may give respondents some examples of new technologies by using both pictures, e.g. pamphlet and verbal descriptions. This is to make sure that they understand the terms of new technologies, e.g. route guidance or in-vehicle information systems. The example of new technologies, i.e. visual (pamphlet or magazine) and verbal are presented to respondents when they have questions regarding the ITS systems.

- Interviewers record the answers. Although, the task looks simple, errors could also occur. The training given to the research assistants include the recording of answer. Thus basically, interviewers would record the answers based upon the questions asked to respondents. In addition, if the response is not full or incomplete, the research assistant is asked to get the full detail or response from the respondents, in which only relevant data are collected. Hence, based upon the training given, it is expected that interviewers' recording of answer is accurate.

- The interviewers also have been asked to edit the questionnaire to check that they have asked all the questions and recorded all the answer. They must ensure that everything is legible. The interviews take approximately 40-50 minutes each depending upon the motivation of both parties. Respondents are given opportunity to ask interviewers if they have any queries regarding the survey.

- The supervisor should be present when interviewers report their completed interview for editing and data analysis. Based upon the responses from all 604 respondents, it was assumed that information gathered was relevant to the aims of the study. For example, the study found that male commuters were higher compared to female. City Hall (1992) has proven this, although the number of female commuters was rising. Thus, it was assumed that interviewers were at their best in interviewing respondents in order to elicit only relevant information for the survey.

5.5.3. Ethical Considerations

The study was based on ethics guidelines related to the interview survey. Participants' responses are confidential and their anonymity is guaranteed. No names were indicated on the completed questionnaires and results of the research cannot be treated to any individual respondent. In addition, it was unlikely that the nature of the question in the survey would adversely affect respondents. No other persons have access to the completed questionnaires.

5.6. Data Analysis

The completed questionnaires were manually entered into a single computer file using a spreadsheet program. The open-ended questions were coded as each different answer was encountered. Although this led to many different codes for question, no information was lost and these codes could collapse into more general response categories later if required. Some of the open-ended questions enabled people to provide multiple responses. Space was provided in the database to accommodate extra responses. Data were screened for encoding errors and compiled using SPSS (Statistical Package for the Social Sciences). Descriptive and inferential statistical analyses were conducted. These were described in the next chapter.

Two kinds of statistical techniques were used, i.e. descriptive and inferential statistics. The purpose of the descriptive statistics is to outline the basic findings of the questionnaire. Descriptive statistics provide summary data such as percentages, overall means and standard deviations. From this information, investigator might be able to provide inferential statistics that brings about insights and draw upon conclusions.

In this survey, frequencies were calculated for all variables of the total sample and for the sample grouped by gender. Meanwhile for other sections especially in the sections of information requirements, navigation and route choice, non-probability statistics were used. The statistical measurements in this study were:

- Gender differences (two unrelated groups) - Mann Whitney U test
- Age differences (three unrelated groups) - Kruskal Wallis test

The critical value for statistical significance was set at $\alpha = 0.05$ for all analysis reported in this chapter. The use of this significance level was based on opinion and advice from several statistical experts, e.g. Rosenthal and Rosnow (1991). The above statistics techniques were used because the nature of data collected limits the use of probability statistics. Consequently, because of the use of non-probability sampling, i.e. purposive sampling, non-probability statistics were used in order to investigate the aims of the survey. Indeed, the use of other types of statistical analysis such as ANOVA, i.e. other probability types of statistical measurement could not be used because the data collected did not match the assumption of probability statistics, such as at least in interval levels.

5.7. Chapter Conclusion

This chapter reviews the method of interview survey. It was decided to employ interview survey for conducting the study regarding driver information requirements because of several reasons. For example, the need to explain several important terms directly to respondents. The survey used questionnaire as an equipment to elicit information. The questionnaire was developed from various information, i.e. previous works, opinion and advice from several persons and others. A formal pilot survey of the questionnaire led to some final modifications before the main survey was conducted. Results of the survey are presented in Chapter 6.

Chapter 6: Survey Results

6.1. Chapter Summary

This chapter describes the results of the interview survey of drivers. The results are presented according to the aims of the study. Firstly, results on navigation strategies, i.e. route planning and wayfinding were presented followed by criteria that drivers use when selecting a route for different types of journeys. Finally, results on information that driver's required, timing and method to present the information were described. The analyses looked at both gender and age differences. A series of detailed discussion of these results appear in Chapter 7.

6.2. General details of the subject population

The total numbers of respondent was 604. Respondents' age ranged from 21 to 58 years old with a mean age of 35.2 years (SD = 7.5). There were 366 (60.6%) male respondents and 238 (39.4%) females. Respondents driving experiences were varies ranging from 2 to 31 year (M = 9.4). The male drivers had their driving experiences ranged from 2 year to 31 years (M = 9.3), whilst the female drivers from 2 year to 30 years (M = 9.6). There was no information available regarding the proportion of male and female drivers and their driving experiences in Malaysia with which the sample could be compared to. It was because the confidentiality of the drivers' records held by the Road Transport Department in Malaysia.

The respondents could be divided into several ethnic groups. For example, forty-two percent of the respondents (n =256) were Chinese. In addition, thirty-five percent (n = 212) were Malay. Meanwhile, twenty-two percent of the respondents (n = 133) participated in the survey involved Indian ethnic and 3 respondents were of Eurasian origin. In term of residential setting, thirty-two percent of the respondents (n = 193) indicated that they live and work outside Kuala Lumpur. In addition, twenty-seven percent of the participants (n = 166) live and work in Kuala Lumpur. Furthermore, twenty-one percent of the commuters (n = 133) live in Kuala Lumpur but work outside Kuala Lumpur whereas eighteen percent of the respondents (n = 112) indicated that they lived outside Kuala Lumpur but work in Kuala Lumpur.

Commuting Trips

Forty percent of respondents (n = 242) choose their route before getting into the car. Whereas twenty-four percent of drivers (n = 147) mentioned that they choose the route while en-route to a destination. In addition, twenty percent of drivers (n = 120) said that they choose route once they are in the car compared to ten percent of respondents (n = 58) who indicated that they choose their route in both situations, i.e. before and once in the car. Indeed, the study also revealed that there were six percent of the drivers (n = 37) indicated they always take the same route to their destination.

Respondents were also asked regarding alternative route. Most of the drivers (n = 408) have a good knowledge on alternative route. The study also revealed that there were other drivers (n = 196) who do not know any other route to their destination, i.e. work. From 408 respondents who have good knowledge regarding alternative route, twenty seven percent (n = 165) know 2 routes. In addition, twenty six percent (n = 158) are familiar with only 1 route. Whereas twelve percent (n = 73) commuters know 3 other routes, and finally only two percent of drivers (n = 12) know more than 4 routes that they could take to and from work.

The survey also investigated driver's future behaviour. The respondents were asked whether they were willing to change routes while commuting. The result shows that the majority of the respondents (n = 423) indicate that they were willing to change route compared to only thirty percent of the drivers (n = 181) who declined to change route while commuting.

The findings also showed that respondent's willingness to change route were also influence by other factors as shown in table 6.1. The table shows the situation of drivers' willingness to change route while commuting.

Table 6.1 Willingness to change routes ...IF

Willingness to change routes....IF	% of responses (N = 423)
I knew in advance about congestion	31.3
I knew the alternative route save my time	24.5
I knew about alternative routes	10.1
There are alternative routes	4.1

The above table shows that the respondents' willingness to change routes while commuting depends upon several conditions. For instance, respondents would change a route or divert to other route if they knew in advance about a congestion. In addition, the results also found that respondents' willingness to change route also depends upon several factors such as the time they start work and flexibility in time when leaving home to work. This clearly shows that the situation where respondents' willingness to use alternative route while commuting is influenced by their working time and departure time, i.e. flexibility in time when leaving home to work or time constraints in the part of the drivers. This finding is also consistent with the results of Caplice et al (1991) study.

6.3. Navigation Strategies

In this section, the results of navigation strategies were broken down into two categories. First, it dealt with wayfinding strategies. Second, it described the result of the route planning method. Three situations of unfamiliar environments were produced in order to ask respondents regarding their navigational strategies, i.e. how they plan their trips and find their way in several unfamiliar destination/environments.

6.3.1. Finding your way in unfamiliar environments

Table 6.2 shows the results of questions regarding wayfinding strategies when travelling to unfamiliar destination/environments, i.e. cities. Respondents were asked to describe how (i.e. the methods they would employ), would they find their way.

Table 6.2. Wayfinding strategies for unfamiliar cities by gender

Lists of wayfinding strategies	% of response Male	% of response Female
Read maps (i.e. road atlas)	25	16
Rely on memory	7	3
Read sketch of route	8	5
Read route notes	3	3
Stop and ask direction	9	6
By trial and error	4	4
Others (e.g. looked at signboard)	4	3

Table 6.2 shows different wayfinding strategies for a trip through unfamiliar cities. The percentages were split by gender. Overall, the most common wayfinding strategies were map referring, i.e. road map and street map, (41%). Drivers also indicated that they would stop and ask someone for directions to their unfamiliar cities (15%). The other method that drivers would employ to guide them to unfamiliar cities/places was sketching of the routes (13%). In addition, drivers also indicated that they would rely on their memory (10%) after studying the route to their unfamiliar destinations earlier before departure. The largest difference was that more male drivers (25%) would consult the map than female drivers (16%). Little difference was observed

between the city wayfinding strategies of males and females. Drivers were reported to use more than one strategies (mean number of responses = 4.10).

Table 6.3 describes the results of respondents' wayfinding strategies when travelling to unfamiliar highways. The most common wayfinding strategy was referring to maps, i.e. road atlas/map (41%). Drivers also would read route notes (16%) and stop and ask for directions (15%). The result clearly shows that drivers would rely on maps in order to find their way while travelling to unfamiliar highways. The figure also shows some differences in wayfinding strategies of both genders. For instance, more female drivers (10%) would read their route notes compared to male drivers (6%). Drivers also listed to use more than one strategies (mean number of responses = 4.25)

Table 6.3. Wayfinding strategies for unfamiliar highway by gender

Lists of wayfinding strategies	% of response Male	% of response Female
Read maps (i.e. road atlas)	26	15
Rely on memory	4	3
Read sketch of route	6	3
Read route notes	10	6
Stop and ask direction	9	6
By trial and error	3	3
Others (e.g. looked at signboard)	4	2

Respondents also were asked regarding the strategies that they use when finding their way through unfamiliar roads. Table 6.4 presented the results of different wayfinding strategies used by drivers for a trip to an unfamiliar road. These percentages were also broken down by gender. The most common wayfinding strategies was to refer to maps, e.g. road atlas/ city map (26%), followed by 20% of the respondents indicated that they would stop to ask for directions. In addition, 13% of the respondents indicated that they use a sketch of the route in order to find their way. The figure shows that the main difference was that more male drivers (12%) would stop and ask for directions than female drivers (8%). No difference was observed between male and female wayfinding strategies. Drivers also listed more than one strategies for finding their ways in unfamiliar roads (mean number of responses = 4.21). There were no difference in the number of strategies listed by gender or age and other variables.

Table 6.4. Wayfinding strategies for unfamiliar road by gender

Lists of wayfinding strategies	% of response Male	% of response Female
Read maps (i.e. road atlas)	15	11
Rely on memory	7	3
Read sketch of route	8	5
Read route notes	6	5
Stop and ask direction	12	8
By trial and error	7	5
Others (e.g. looked at signboard)	6	2

6.3.2. Unfamiliar journey planning strategies

This study also investigated the route planning strategies that commuters use when they plan a trip to unfamiliar destinations. Respondents were asked to describe how, i.e. strategies employed, to plan their unfamiliar trips. The trips were divided into three different categories: city, highway and road.

Table 6.5 shows different route planning strategies for a trip along an unfamiliar city and the percentage of respondents who use them. The most common planning strategies for all drivers was to consult a map, e.g. road atlas & city maps (25%) and have an acquaintance to do the planning (12%). The next common strategy identified was going without any preparation (12%). The largest difference was that more male drivers would consult maps (16%) than female drivers (9%). However, there was no gender difference in route planning strategies. On average, drivers reported to have employed more than one strategies (mean number responses = 4.02).

Table 6.5. Route planning strategies for unfamiliar cities by gender

Lists of route planning strategies	% of response Male	% of response Female
Look at maps (i.e. road atlas)	16	9
Acquaintance did the plan	8	4
Went without planning	6	6
Made notes	6	4
Made a sketch	5	3
Use motoring organisation info.	5	3
Asked someone for route info.	5	4
Looked at signboard	3	3
No answer	6	4

Table 6.6 shows the result of different route planning strategies respondents would use for their trips along an unfamiliar highway. These percentages were split by gender. The most common planning strategies to all drivers is to consult a map, e.g. road atlas/city map, (27%). Another planning strategy that drivers indicated is to have an acquaintance to do the planning (14%). Drivers also indicated that they would go without planning to their unfamiliar destinations (14%). The result shows that drivers would refer to maps than to others strategies. However, the study also shows that some drivers think that they are capable to reach their destinations without any preparation (e.g. to go without planning). The study also showed that male drivers (8%) would go without any preparation to their destination compared to female drivers (6%). However, no difference was observed between male and female planning strategies. The drivers listed more than one strategies to plan their trips to unfamiliar highway (mean numbers of responses = 4.01). There was no difference in the number of strategies listed by gender, age and other variables.

Table 6.6. Route planning strategies for unfamiliar highway by gender

Lists of route planning strategies	% of response Male	% of response Female
Look at maps (i.e. road atlas)	17	10
Acquaintance did the plan	8	6
Went without planning	8	6
Made notes	7	4
Made a sketch	5	4
Use motoring organisation info.	4	2
Asked someone for route info.	6	4
Looked at signboard	2	2
No answer	3	2

Table 6.7 shows that the most common planning strategies for all drivers were also to consult a map, e.g. road atlas/city map (24%), ask an acquaintance to plan the route (13%) and to go without planning (11%). The next common strategy identified is to ask someone for route direction (10%). The largest difference noted was that more male drivers (9%) ask their acquaintance to plan the trips compared to female drivers (4%). No difference was observed between male and female planning strategies. Similar with other situations, drivers were reported to use more than one strategies (mean number of responses = 4.20).

Table 6.7. Route planning strategies for unfamiliar road by gender

Lists of route planning strategies	% of response Male	% of respons Female
Look at maps (i.e. road atlas)	15	9
Acquaintance did the plan	9	4
Went without planning	6	5
Made notes	6	4
Made a sketch	5	4
Use motoring organisation info.	4	4
Asked someone for route info.	6	3
Looked at signboard	5	3
No answer	4	4

6.4. Route Choice Criteria

Table 6.8 shows the importance of criteria that drivers would use in order to choose a route from home to work. Respondents were asked to rank the criteria on a 5-point scale ranging from *Very Important* to *Not At All Important*, (where 1 = very important and 5 = not at all important). The table shows the responses of drivers regarding route choice criteria which influence their decisions to select certain route for home to work trips.

The findings (See Table 6.8) clearly exemplify the difficulty in arriving at an universal conclusion about the relative importance of route choice attributes. The study revealed that drivers' preferences for various route choice criteria varies. For instance, some of the respondents clearly indicated that they are in favour of saving mileage or time, while others place the importance on safety for route choice criteria. The study showed that the five most important criteria in selecting a route when making trips to work from home are safety, saving time, saving mileage, certainty of arrival time and avoiding congested route.

Table 6.8. Route choice criteria (home - work)

Criteria	Mean Scores	% '1, 2'
Safety	2.14	67.5
Saving time	2.28	61.1
Saving mileage	2.31	59.9
Certainty of arrival time	2.37	57.9
Avoiding congested route	2.42	55.5
Fewest stops	2.48	53.3
Good traffic flows	2.48	52
Less traffic	2.49	52.3
Fastest route	2.51	52.6
Least complicated route	2.57	49.3
Convenience/accessible	2.67	46.5

Statistical analysis shows the differences between age of respondents concerning the criteria used in selecting a route to a particular destination e.g. home to work. For example: *Age* - The analysis revealed significant difference between different age groups toward safety criteria. Indeed, respondents who were 45 and above regarded safety as their main priority or important criteria when choosing a route to work [$\chi 2$ (2) = 7.67; p < o.o5).

Table 6.9 shows that the result of route choice criteria for work to home trips. The result clearly showed that there is no universal agreement regarding route choice criteria that affect drivers' route choices for their work to home journey. For instance, respondents' placement of importance on factors such as safety, saving mileage, avoiding congested route, fastest route and less traffic act as a good indicator for drivers' route choice criteria. The results of the statistical analysis revealed that there are differences between gender and age of drivers regarding the employment of certain route choice criteria for work to home trips.

Gender - There was significant difference between male and female drivers regarding criteria that they use in selecting route for work to home trips. The result shows that females have the more preference to avoid congested route more than males ($Z = 2.25$; $p < 0.05$). This clearly shows that females rated this criterion as important in selecting a route to their home.

Age - The Kruskal-Wallis tests revealed the main effects of age on several of the criteria of route choice. Observation of mean values showed that older drivers rated fastest route as one of the criteria that they use in selecting a route compared to other age categories of respondents, [$\chi^2(2) = 7.46$; $p < 0.05$]. Thus, one may conclude that older respondents tend to select the fastest route as one of their main criteria to choose a route to their home.

Table 6.9. Route choice criteria (work - home)

Criteria	**Mean Scores**	**% '1, 2'**
Safety	2.29	61.3
Avoiding congested route	2.47	54.1
Saving mileage	2.48	54.5
Fastest route	2.50	52.2
Saving time	2.52	50
Less traffic	2.57	50.7
Good traffic flows	2.62	47.5
Fewest stops	2.63	48.7
Convenience/accessible	2.68	46
Least complicated route	2.72	44.4
Certainty of arrival time	2.83	41.7

Table 6.10 shows several factors that influence drivers route choice criteria for unfamiliar trips. Most of the respondents (65%) indicated safety as the good predictor for selecting a route, followed by less traffic (60%), avoiding congested route (57%), good traffic flow (57%) and saving mileage (54%). However, the study also found that some of the respondents preferred to tick the "do not know" options. In addition, some of the respondents also preferred to answer "not important" in terms of several criteria such as fewest stops and good scenery.

Table 6.10. Route choice criteria (unfamiliar trips)

Criteria	Mean Scores	% ' 1,2'
Safety	2.20	65
Less traffic	2.32	60
Good traffic flows	2.39	57
Avoiding congested route	2.39	57
Saving mileage	2.43	54
Convenience/accessible	2.46	52.8
Fastest route	2.48	52.3
Least complicated route	2.50	51.7
Most relaxing routes	2.52	52
Certainty of arrival time	2.54	51.5
Fewest stops	2.57	48.8
Saving time	2.59	48.8
Good scenery	2.73	45.8

The statistical analysis shows that there is a difference between age and route choice criteria. For example: *Age* - there was the general trend for older respondents to prefer safety and less traffic criteria as their main criteria to select a route when travelling to unfamiliar destination. For safety, the Kruskal-Wallis tests revealed a difference among the three groups, [$\chi 2$ (2) = 5.78; $p < 0.05$]. This was also similar in the case for less traffic as shown by the test, [$\chi 2$ (2) = 8.38; $p < 0.05$].

In conclusion, we could see that drivers would use variety of criteria in selecting routes for several types of journey, e.g. commuting or unfamiliar trips. For instance, in the home to work and work to home trips, there were similar criteria that drivers would use in selecting a route. Criteria such as safety, saving mileage and avoiding congested route are employed in both trips. This may suggest the importance of the factors in influencing drivers' decision on which route to be taken to their destination, e.g. home or work.

Nevertheless, there were other factors, which might be related to the nature of the trips that drivers make. For example, criteria such as saving time and certainty of arrival time were employed quite high by drivers in home to work trips. This may suggest that drivers need to be certain regarding their trips to their destination. Drivers need to save time while commuting to work (e.g. Noland, 1997).

Drivers also employ various types of criteria in selecting route for unfamiliar trips. For instance, drivers would select routes which are safe, have less traffic, not congested, have good traffic flows and reduce mileage. This might suggest that these criteria could help drivers in reaching their destination. Nevertheless, there was a similarity regarding criteria that drivers would use in selecting route for three different types of journey. The study showed that drivers in home to work, work to home and unfamiliar trips used safety, saving mileage and avoiding congested route criteria in selecting route. This implies that these criteria are important for drivers. In addition, drivers do not use single value or factor in selecting routes but they would employ variety of factors/attributes in choosing routes. However, other factors also may have influenced drivers decision in selecting routes, e.g. gender or age (Abdel-Aty et al, 1997).

6.5. Information Requirements

In this section, respondents were asked to indicate their information needs and rank the importance of information for several trips purposes, e.g. commuting and unfamiliar trips. The ranking was based upon the most important to the least important (1st to 5th). Traffic information that drivers require from home to work trips is presented in Table 6.11.

Table 6.11 - Preferences for information requirements (home-work)

List of Information requirement	% of responses
1st) Congestion	53.4
2nd) Route guidance	51.4
3rd) Alternative route	47.8
4th) Parking guidance	44
5th) Traffic state prediction	42.6

The above table shows the results of respondents' information requirements for commuting trips (i.e. home to work). The figures refer to the percentage of the subject's response regarding the importance of information. The result shows a driver's information need varies. For example, information on congestion was ranked the most important. Next, route guidance was marked as second most important followed by alternative route, i.e. as the third most important information. In addition, parking guidance was placed the fourth most important information. Finally, subjects identified traffic state prediction as one of the most important information when commuting to work. The result of the statistical analysis showed no differences between gender and age group regarding the information that respondents required.

Table 6.12 shows five most important information that respondents would require when commuting from workplace to home. Among others, drivers listed congestion, alternative route, trip planning, traffic state prediction and rules & regulations. The result shows there are differences concerning the information that respondents required.

Table 6.12 - Preferences for information requirements (work-home)

List of Information requirement	% of responses
1st) Congestion	42.7
2nd) Alternative route	39.2
3rd) Trip planning	36.1
4th) Traffic state prediction	31.4
5th) Rules & regulations	28.3

The statistical analysis of the data revealed there were differences between gender and age of respondents concerning the information that respondents required.

Gender - The finding shows that female drivers would prefer to rank congestion as their most important information compared to their counterpart, e.g. male ($Z = 3.32$; $p < 0.05$). Indeed, observation of the mean values clearly shows that female was higher than male drivers.

Age - The analysis reveal a significant difference in the age factor regarding the third information that drivers required, e.g. trip planning. The findings showed that group 2 (e.g. middle age drivers) would prefer to have trip planning information compared to the younger and older drivers' ($\chi 2 = 8.17$ (2) $p < 0.05$). It can be observed based upon the mean values of three age groups. For instance, group 1 = 296.9, group 2 = 325.2 and group 3 = 262.5. Thus, it shows that middle age drivers need for trip planning more than other groups.

Respondents were also asked to rank the importance of information that they would required when dealing with congestion while on their way to and from their destination, e.g. home or work. Table 6.13 presents the findings of the respondents' information requirements in dealing with congestion while on their way from home to work.

Table 6.13 - Preferences for information requirements (dealing with congestion while on the way from home-work)

List of Information requirement	% of responses
1st) Condition of Congestion	31.8
2nd) Speed of vehicle	31.2
3rd) Alternative route	27
4th) Location of congestion	25
5th) Traffic state prediction	23

The above table shows that respondents prefer information on condition of congestion as their main priority information which could help them in dealing with congestion when travelling to work. In addition, respondents also listed other types of information such as speed of vehicle, alternative route, location of congestion and traffic state prediction. The result also showed the differences between gender regarding the information requirements on congestion.

Gender - There are significant differences between male and female concerning two types of information. First, female respondents prefer to know more about location of congestion compared to males ($Z = 1.98$; $p < 0.05$). Second, as for information on traffic state prediction, the result shows that female drivers also prefer to have more knowledge on such information than the opposite gender, e.g. male ($Z = 3.23$; $p < 0.05$). This probably suggests that female put a high ranking on both types of information and they would prefer to know more on these information compared to the male respondents.

Table 6.14 shows that respondents also prefer to have information regarding condition of congestion in dealing with congestion when commuting from work to home. It was followed by the information on weather. The table also reveals the need to know in advance of information regarding alternative route and location of the congestion. Finally, respondents stated that they also require information regarding traffic volume.

Table 6.14 - Preferences for information requirements (dealing with congestion while on the way from work-home)

List of Information requirement	% of responses
1st) Condition of Congestion	34.5
2nd) Weather	29.2
3rd) Alternative route	25.8
4th) Location of congestion	25.7
5th) Traffic volume	25.6

The study also asked respondents to rank the importance of information that they need to have in advance in deciding whether to divert to alternative route when their regular route is congested while on their way to their destination, e.g. from home to work and work to home. Table 6.15 shows the results of drivers' needs regarding alternative route information for home to work trips.

The table shows the result of information requirements for alternative route and the ranking of its importance. The finding shows that respondents indicated their preferences regarding information which could help influence their decisions whether to divert to alternative route. They prefer to have information on the length of alternative route followed by information on traffic volume on alternative route. In addition, respondents also indicated the need for information on the congestion on their usual route prior to deciding whether to divert to alternative route. Respondents also stated that they would like to have information regarding the difference in travel time between routes. Finally, the study revealed that respondents also require information regarding the ease of access to alternative route.

Table 6.15 - Preferences for information requirements (deciding to divert to alternate route while on the way from home-work)

List of Information requirements	% of responses
1st) Length of alternative route	35.2
2nd) Traffic volume on alternative route	26.4
3rd) Congestion on usual route	26.3
4th) Difference in travel time between two routes	23.9
5th) Ease of access to alternative route	21.6

The findings reveal there was differences between male and female respondents regarding their information requirements. For instance:

Gender - The study shows that female drivers would prefer the information on the difference in travel times between two routes compared to male respondents ($Z = 4.24$; $p < 0.05$). This could imply that female drivers are more concerned in regards to the travel time between two routes compared to male drivers (i.e. based upon mean value; Male = 278.4 compared to Female = 339.5).

Table 6.16 presents the results of drivers' information requirements for alternative route. The findings clearly show that respondents would like to have information regarding the length of alternative route as their most important information for work to home commuting trips. It was followed by information regarding level of congestion on their original route as their next important information before deciding to divert to alternative route. In addition, the respondents also indicated the need to have in advance for information concerning the location of alternative route. They also prefer to have information concerning traffic prediction on alternative route. The study also found that respondents indicated information regarding the condition of alternative routes as their fifth most important item required when deciding to divert to alternative route.

Table 6.16 - Preferences for information requirements (deciding to divert to alternate route while on the way from work-home)

List of Information requirement	% of responses
1st) Length of alternative route	28.3
2nd) Level of congestion on original route	25.6
3rd) Location of alternative route	23.8
4th) Traffic prediction on alternative route	14.7
5th) Condition of alternative route	11.8

The study also asked drivers whether they have had experience driving to unfamiliar destination or trips. Thus, experienced drivers were defined as drivers who have the experience travelling to unfamiliar environments. The study found that experienced drivers' preference on information needs varied. They need information on route guidance, followed by traffic condition. In addition, they would also like to have alternative route information and congestion. Finally, respondents also prefer to have information on road condition. Table 6.17 shows the result of experienced drivers' information requirements for unfamiliar trips.

Table 6.17 - Preferences for information requirements (Experienced drivers - unfamiliar trips)

List of Information requirement	% of responses
1st) Route guidance	24.2
2nd) Traffic condition	23.2
3rd) Alternative route	23
4th) Congestion	21.1
5th) Road condition	18.8

The statistical analysis revealed some differences regarding the above results. For instance: *Age* - The Kruskal Wallis tests revealed the main effects on age for traffic condition. Observation of mean values showed that older drivers ranked traffic condition higher than their other counterparts, e.g. younger and middle age drivers ($\chi 2 = 6.52$ (2); $p < 0.05$). This may suggest that older drivers prefer information on traffic condition more than the other age groups, e.g. younger or middle age respondents.

While for inexperienced drivers (who claimed that they had never traveled or driven to unfamiliar destination or environments) prefer to have information on route guidance, followed by information on alternative route, which was identified as the second most important information. Furthermore, they also prefer to have congestion information and incident detection when driving to unfamiliar destinations. Last but not least, drivers indicated the need to know the traffic condition (See Table 6.18). The statistical result also demonstrated some differences in information need. For instance: *Age* - The test revealed that the middle age group prefers information on traffic condition compared to other age groups drivers ($\chi_2 = 7.38$ (2); $p < 0.05$). This may suggest the different criteria used in ranking the importance/preferences of drivers' information requirements. Indeed, middle age inexperienced drivers prefer this information more than other groups, e.g. younger or older.

Table 6.18 - Preferences for information requirements (Inexperienced drivers - unfamiliar trips)

List of Information requirement	% of responses
1st) Route guidance	15.2
2nd) Alternative route	15
3rd) Congestion	12.9
4th) Incident detection	11.2
5th) Traffic condition	11

6.6. Timing of information presentation

Respondents also have been asked to indicate when was the appropriate timing to present the information that they require for several journey purposes. Table 6.19 presents the result of the timing of information when commuting from home to work. The result clearly shows that respondents want the information given to them while they are driving to their destination. For instance, respondents would prefer information on congestion, route guidance, alternative route, parking guidance and traffic state prediction to be given to them while they are on their way to their destination, compared to other situations e.g. before starting the journey and in both condition, i.e. before and while driving to their destination.

Table 6.19. Timing of information presentation (home-work)

	Before the trip %	During the trip %	Both situations %
Congestion	31	48	21
Route guidance	24	49	27
Alternative route	30	47	23
Parking guidance	29	39	32
Traffic state prediction	35	38	28

Table 6.20 also shows that some respondents would like to have the information while driving to their destination. (e.g. for work to home commuting trips). Information on congestion, trip planning and rules & regulation should be given to the drivers while on their way to home from work. Nevertheless, respondents also prefer to be given some information in both situations, e.g. before and while driving to destination. The two types of information required in both situations are alternative route and traffic state prediction.

Table 6.20 Timing of information presentation (work-home)

	Before the trip %	During the trip %	Both situations %
Congestion	30	40	30
Alternative route	34	29	37
Trip planning	31	51	18
Traffic state prediction	24	32	45
Rules & regulations	27	44	29

Table 6.21 shows the result of the respondents' response regarding the appropriate timing to present the information when dealing with congestion while on their way to work. The study found three types of information that should be given to drivers while on their way to work. The information includes the speed of vehicle, location of congestion and traffic state prediction. The result also shows that the only one type of information which respondents need in both situations, i.e. before and while driving to their destinations is the information on alternative route. Besides that, respondents also prefer information on the condition of the congestion which should be given before they depart for work.

Table 6.21 Timing of information presentation when dealing with congestion (home-work)

	Before the trip %	During the trip %	Both situations %
Condition of congestion	35	34	31
Speed of vehicle	29	37	34
Alternative route	31	32	37
Location of congestion	32	35	33
Traffic state prediction	34	35	31

Table 6.22 shows the results of timing of information that respondents require when dealing with congestion while on their journey from work to home. The study clearly shows three types of information that should be given to the drivers before they begin their trips. The information should include the weather, location of congestion, and traffic volume. The other two types of information that they need while driving to their destinations are the condition of the congestion and the choice for an alternative route.

Table 6.22 Timing of information presentation when dealing with congestion (work-home)

	Before the trip %	During the trip %	Both situations %
Condition of congestion	26	45	29
Weather	40	31	29
Alternative route	31	39	29
Location of congestion	37	34	29
Traffic volume	38	34	28

Suitable timings to present the information regarding alternative route while making trips from home to work varies (See Table 6.23). For instance, information such as traffic volume on alternative route, congestion on the usual route and the access to alternative route should be given to the drivers while driving to their destination. However, information concerning the length of alternative route and difference in travel time between the route is required before starting the journey.

Table 6.23 Timing of information presentation when deciding to divert to alternative route (home-work)

	Before the trip %	During the trip %	Both situations %
Length of alternative Route	40	33	27
Traffic volume on Alternative route	31	36	33
Congestion on usual Route	29	38	33
Difference in travel time between routes	34	33	33
Ease of access to Alternative route	27	41	32

Table 6.24 shows that information such as length of alternative route and level of congestion on original route are required before drivers start their journey. In addition, traffic state prediction on alternative route is needed while they are driving to their destination. However, the study also shows that drivers indicated that information regarding location of alternative route and condition of alternative route should be presented in both conditions, e.g. before and while driving to their destination.

Table 6.24 Timing of information presentation when deciding to divert to alternative route (work-home)

	Before the trip %	During the trip %	Both situations %
Length of alternative Route	36	33	31
Level of congestion on Original route	37	32	31
Location of alternative Route	29	35	36
Traffic prediction on Alternative route	31	36	33
Condition of alternative Route	31	34	35

Table 6.25 shows the appropriate time to present the information while driving to unfamiliar destination. The result shows that experienced respondents like to have several

information before they start their journey to unfamiliar destinations, e.g. route guidance, alternative route, congestion and road condition. In addition, the study also found that only one type of information should be given while driving to the unfamiliar destination, e.g. traffic condition.

For inexperienced drivers (e.g. who claimed they had never travelled to unfamiliar destination before), three types of information are required while driving to unfamiliar destinations (See Table 6.26). The information includes alternative route, congestion and incident detection. However, two types of information are required before drivers start their journey, e.g. route guidance and traffic condition.

Table 6.25 Timing of information presentation when driving to unfamiliar destination (experienced drivers)

	Before the trip %	During the trip %	Both situations %
Route guidance	22	17	16
Traffic condition	18	21	16
Alternative route	25	20	10
Congestion	29	16	10
Road condition	28	17	10

Table 6.26 Timing of information presentation when driving to unfamiliar destination (inexperienced drivers)

	Before the trip %	During the trip %	Both situations %
Route guidance	25	14	6
Alternative route	11	22	12
Congestion	9	27	9
Incident detection	10	26	9
Traffic condition	10	27	8

6.7. Method to present the information

The respondents in the study were also asked to indicate their preferable method/medium to present the information they require for several journey purposes, e.g. commuting trips. Table 6.27 shows that in commuting from home to work trips and vice versa, most of the respondents indicated that they would prefer to receive the information that they require for commuting trips from the commercial radio.

Table 6.27-Preferable method to present information (commuting trips)

List of the method	Pre-trip	En-route
Commercial radio	49.2%	49.2%
Mobile phone	14.6%	14.6%
Television	8.5%	—
In-vehicle systems	7.3%	7.3%
CB radio	—	8.3%
VMS	—	6.6%
Advisory radio	—	5.5%
No responses	20.4%	8.5%

The study found that drivers choose commercial radio as the preferred medium to present the information. However, they also prefer other types of information presentations such as mobile phone and in-vehicle systems that could present the information in both conditions, i.e., pre-trip, e.g. en-route to home or work. The table also shows that some of the respondents would prefer to use CB radio, VMS and advisory radio in order to be informed regarding their information requirements.

Table 6.28-Preferable method to present information (dealing with congestion)

List of the method	Pre-trip	En-route
Commercial radio	44.4%	44.4%
Mobile phone	11.6%	11.6%
Television	7.9%	—
In-vehicle systems	9.1%	9.1%
CB radio	—	9.1%
VMS	—	10.1%
Advisory radio	—	7.8%
No responses	27%	7.9%

Table 6.28 shows that respondents would prefer to use commercial radio in order to be given information that they require when dealing with congestion for both situations from home to work and vice versa. In addition, the respondents also indicated that they need to be informed before they start their journey (pre-trip) and while on their journey (en-route) to their destinations, e.g. commuting to and form work. The study clearly shows that most of the

respondents like to receive traffic information from commercial radio compared to other modes of information presentation.

Table 6.29 shows the respondents' preference of modes to present the information. They would prefer to receive the information required as to when to decide to divert to alternative route form commercial radio in both situations, i.e. pre-trip and en-route to their destination, whether to home or work. In addition, there were also other types of medium that drivers prefer such CB radio and VMS.

Table 6.29-Preferable method to present information (deciding to divert to alternative route)

List of the method	Pre-trip	En-route
Commercial radio	32.5%	32.5%
Mobile phone	11.6%	11.6%
Television	7.8%	—
In-vehicle systems	9.3%	9.3%
CB radio	—	15.4%
VMS	—	11.6%
Advisory radio	—	11.8%
No responses	38.8%	7.8%

Table 6.30-Preferable method to present information (unfamiliar trips)

List of the method	Pre-trip	En-route
Commercial radio	26.6%	26.6%
Mobile phone	12.1%	12.1%
Television	9.6%	—
In-vehicle systems	9.3%	9.3%
CB radio	—	20.4%
VMS	—	12.7%
Advisory radio	—	9.3%
No responses	42.4%	9.6%

Table 6.30 shows that 26.6% of the respondents prefer commercial radio compared to 20.4% of the respondents who are in favour of using CB radio. In addition, the use of commercial radio is high in both situations, e.g. pre-trip and en-route to unfamiliar destinations while CB radio is only limited to the en-route to their destinations. Furthermore, some of the respondents also prefer to use the information from their television, i.e. before they start their

journey to unfamiliar destination compared to advisory radio which presents information while they are en-routing to the destination.

6.8. Summary of the results

The results show very interesting findings regarding the aims of the research. For example:

- The information that drivers require varied and different types of journey influence the requirements for information. For instance, for commuting trips such as home to work and vice versa, drivers require quite different kinds of information. Indeed, this may suggest drivers need various kinds of information rather than having a single information. For example, the respondents in this study revealed that before they decided to divert to alternate route while en route to work, they would prefer to have information such as length of alternative route, traffic volume on alternative route, congestion on usual route and difference in travel time between the two routes. In addition, respondents also indicated the need for different kinds of information while on their way to home from work, such as traffic prediction on alternative route, condition of alternative route and level of congestion on original route.

- Furthermore, some of the information required in the one trip (e.g. to work) is also needed in the other trips (e.g. to home). This may suggest the importance of the information in influencing drivers' decision. Finally, different categories of drivers, i.e. experienced, gender or age also revealed differences in information requirements. Thus, the findings are consistent with other previous works by Tsai (1991) and Haselkorn et al., (1981) in which they mentioned that drivers population could not be treated as homogeneous in having similar needs for information.

- Respondents prefer commercial radio compared to other types of medium, e.g. VMS or in-vehicle systems. In addition, different types of journeys and drivers may influence the different timings in presenting the information. Some of the drivers may prefer to receive information before the trips. It may help them in several ways such as to change route or modify their departure time.

- However, there were also respondents who prefer to be given information while making the trips. This may also help in influencing their diversion behaviour (e.g. Khattak et al., 1993). Thus, as a conclusion, the responses should be treated with caution because of the subjectivity of the information supplied by the drivers. Consequently, the information may not reflect the true nature of the systems and real traffic situations which may produce different kinds of timings to present the information.

- Drivers may employs various types of navigation strategies, e.g. route planning and wayfinding. In addition, the survey shows that in average drivers would use 4 different types of strategies while travelling to three different kinds of environments. This may suggest that drivers do not focus upon only one strategy as they would use other strategies in order to achieve their aims, e.g. finding their way in unfamiliar destination.

- The most common strategy that drivers would use was by referring to maps. In addition, they would also ask someone for route information, e.g. people in the vicinity of the environment or an acquaintance. Respondents would go without planning and refers to their sketch or route notes. Finally, some of them would rely on their memory in finding their unfamiliar environments.

- Different criteria were used in selecting a route in different types of journey. However, in general, drivers would place safety as the most important criterion in selecting a route. Different criteria were employed depending upon the nature of the trips. For example, when commuting to work, most of the criteria were related to the time, e.g. certainty of arrival time, saving time or saving mileage. Thus, we may suggest that the nature of trips may influence the usage of criteria by drivers.

- In addition, there are also differences between gender and age regarding the criteria used in selecting a route for several types of trips. This may imply that different types of drivers may use different kinds of criteria in choosing a route.

6.9. Chapter Conclusion

The results of the interview survey of driver information requirements and other issues were described in this chapter. Drivers require different types of information in different kinds of journey or situations, e.g. commuting trips vs. when deciding to divert to an alternative route. In addition, drivers also would use different types of strategies while travelling to different kinds of unfamiliar destinations. The most dominant strategy used for both route planning and wayfinding is to refer to maps compared to other types of strategies. In addition, respondents would also employ different kinds of criteria in choosing a route. Nevertheless, safety is still the main priority when selecting a route. As shown in the previous works, drivers require more information rather than only one. In addition, the need of variety of types of information justified the ever-changing condition of traffic in real-life situation. Thus, the findings may help systems designers to think about developing more related types of information that could assist drivers. These results are discussed in Chapter 7.

Chapter 7: Survey Discussion

7.1. Chapter Summary

This section examines and discusses the results of the interview survey in relation to the research literature and the thesis aims. The first discussion is on the methodology issues. In the next section, discussion is focused upon drivers' navigation strategies, e.g. route planning and wayfinding. It is followed by the criteria that drivers used in selecting a route. Finally, the discussion is concentrated on driver information requirements.

7.2. Methodology Issues

Based on the result of the preliminary studies, the interview survey was chosen to collect relevant data from a larger sample, e.g. commuters, regarding their information needs. The following points highlight some of the drawbacks which may have had a confounding effect on the findings of the study.

- Purposive sampling were used to pick up respondents. This non-probability sampling technique did not ensure equal chances of potential respondents to be involved in the study. Hence, the respondents did not represent the motorists' population in Kuala Lumpur. The findings were questionable and caution should apply when generalizing it to the motorists' population in Malaysia.

- On the other hand, there was no reported study in Malaysia regarding motorists' population. However, the investigators had to assume that respondents who participated were indeed commuters. Having been screened first before being selected, it could be assumed that they all came from a pool of motorists' population in Kuala Lumpur.

- The instrument used (e.g. questionnaire) has a lower validity and reliability. Both aspects could affect the collection of information and the truthfulness of the responses given by the respondents. Indeed, the information cannot be compared to the available information/material because there is no reported studies or available information regarding this issue.

- The approach, i.e. the interview procedure, used in the study was also subject to various problems, such as interviewees may not supplied the actual information. It is because before the survey commenced, both the interviewer and interviewee have a prior distribution of expected answer on questions (e.g. Hyman, 1975). This expectation could hamper and bias the progress of the interview. Nevertheless, in order to avoid such a problem, interviewees were guaranteed that their response were only for the research purposes and would be treated with confidentiality.

- The Interviewers were trained so that they were capable in eliciting relevant information. They were asked to explain the meaning of the issues or term precisely. The term used in the survey was explained with the use of several examples (e.g. verbal or picture) in order to convey the meaning to the respondents. However, it is not known whether respondents clearly understood the meaning of the terms, e.g. route guidance, in-vehicle information systems, VMS, advisory radio and others. Consequently, this could influence the respondent's response. However, the usage of several examples, e.g. verbal description and picture could enable interviewers to convey the exact meaning of the terms. It also could enable interviewees to imagine and understood the term explained by interviewers.

- There is no indication as to the reliability in subjects' responses on various new issues. However, it was assume that their responses were appropriate which was based upon their driving experience. Nevertheless, in certain cases, participants' responses were based solely on their preferences/opinion which is rather subjective in nature.

- Socially desirable response issue. This issue meant that the responses that the respondents gave could be based on the assumption thtat the responses are what they "should" believe rather than what they actually do believe. However, the interviewers were trained to handle this kind of problem. The Interviewees were asked to give their true answer or the answer that they believe are the possible ones. Interviewers have to convince the respondents that their responses would be used for research purpose.

- Issues such as response order, i.e. memory errors and recency effect could also affect the progress of data collection. Memory errors occurred when respondents lose track of all option, and pick one that comes to mind easily rather than the most accurate one. Recency effect was the tendency of the respondents to choose the first or last response regardless of content or to acquiesce/agree with items regardless of their true feelings. In this interview, some of the respondents tend not to answer some of the questions. This could jeopardize the interview and the information collected. Both errors could make the information useless because the data collected were not based on respondents' true feelings or experience. In fact, some of the responses were based on subject stated preference approach, i.e. what they believe rather than what they have experienced. Thus, the information should be treated with caution in generalizing it to the overall commuters' population in Malaysia.

- The questionnaire used in this survey was also subject to 'fatigue effect' or a ' questionnaire length effect'. This effect implies that prior questions have led the respondents to interpret the questions differently and hence responded differently. This could be true if too many questions were put in the questionnaire. However, the interviewers were asked to have a break or stop temporarily if the respondents show signs of tiredness. After they have recovered, the interviewers could restart the interview. This procedure was one of the important aspects in the interviewer's training. It is because the interview itself sometime take about 45 minutes to 1 hour. Thus, it was advisable to have a break or pause in between the interview. In addition, interviewers also were asked to motivate respondents especially when asking question and recording their answer. Although, Bradburn & Sudman (1979) found that there is no difference regarding 'fatigue effect' on length of questionnaire, this issue has been encountered during the interviewers training in order to ensure that interviewers apply the appropriate action when such a problem arises.

- The survey itself could be a source of measurement error. This issue cover the like of the questionnaire used and questions asked to the prospective interviewees. In terms of the questionnaire, issue such as how the questionnaire are worded, the structure of the questions and the order or context of question are some of the aspects that contribute to a measurement error. The error could occur because the questionnaire was used as a script for the interviewer. During the data collection, the questionnaire was assumed as an integral component of interviewers' behavior (e.g. Andersen, et al., 1979). In this survey, questionnaire has been piloted before the main survey. In fact, some of the changes have been made in order to make sure that the target audience understood the questions. However, there is no proof that the questionnaire used was free from error or any mistake. In fact, some respondents reported they did not like to answer some of the questions such as one on their education level. Nevertheless, interviewees were given assurance that the information supplied by the respondents were treated as confidential and only for the uses of research. Consequently, some of the respondents gave very good response regarding several issues and in fact, some of it could well represent drivers' real life situation or experience.

Although the method used in the study, e.g. interview survey has several disadvantages, the procedure also has some merit regarding the collection of vital information needed in the study. For example,

- The procedure was considered useful in collecting some vital information such as information requirements and others compared to other procedure such as postal survey. The need to explain several technical terms or jargon terms used in the survey highlighted the advantages of using interview survey. By explaining the terms to the respondents that they would understand the terms and give the actual response toward the issue being studied.

- Indeed, the training given to the interviewers were thought to enhance the reliability and confidentiality of response given by the respondents. In fact, the interviewers gave their best in eliciting vital information from the respondents. For example, complex and vital information such as route choice and information requirements could be gathered.

- Respondents also have the choice to ask and comprehend some of the technical terms as explained by the interviewers compared to a postal survey where such option cannot be made available.

- Although there is no available information or reported data on the above issue, e.g. information requirements, the data gathered from the study by using the interview survey could be used as a guideline for other local study, which also investigate the same issues. Therefore, in the future, this method should be used with other types of procedure such as objective measures; e.g., simulation or road track tests in order to collect more reliable types of data from potential respondents.

- This is the first study in Malaysia which involved the investigation of drivers' information requirements. Limited facilities such as simulation or road track test prevented the use of other objective measures in eliciting the vital information in this study. However, the information given by the respondents in this survey was vital and could be used to compare with the other studies, i.e. local or abroad in order to establish the pool of the information requirements of drivers. Indeed, some of the information that local drivers required were similar with the information needs of other drivers in developed countries such as Europe and Japan. This findings highlighted that the interview survey used in this study is capable in producing similar results compared to the other method such as postal survey or simulation.

In conclusion, although the usage of interview survey had some disadvantages, there are some advantages obtained from the study. Nevertheless, in future study, this method should be used in relation with other methods preferably in terms of the subjective approach in collecting more data regarding drivers' information requirements for designing motorists information systems. Although, the method proved to be favourable, the findings should be treated with caution whenever one tries to generalize to drivers' population in Malaysia.

7.3. Route planning strategies

One of the objectives of the study was to find out how, - in reference to the strategies used- drivers plan their unfamiliar journeys. Route planning strategies are the navigational preparations that people make before driving to an unfamiliar place. In three different environment/settings, e.g. cities, highway or road, mostly drivers refer to maps to plan their trips to those settings. The next common strategy in the three settings were to stop and ask for directions and went without planning. In this section, inferential statistic analysis could not be conducted because these strategies were not exclusive as the assumption of independent responses was not met.

On average, the respondents have a tendency to report of using more than one strategy. Thus, they would apply route notes from a map and from information given by someone. As mentioned earlier, this study showed that route-planning strategies did not differ despite in three different settings that were unfamiliar to them. In addition, route-planning strategies were similar in the case of gender or age groups of the respondents. This clearly illustrated that both aspects did not play a significant part or have an influence in the kind of strategies drivers would or have been used in planning their unfamiliar trips. However, one could argue this assertion because several previous works showed that there are differences between male and female drivers in terms of strategies used for route planning. For example, Streff & Wallace (1993) found that paper maps were used more often and is preferred by male drivers compared to female.

The usage of maps as the most common strategy employed by the respondents were in complete agreement with route planning method identified in previous research (e.g. Streff & Wallace, 1993). The usage of maps by both genders in three different setting explained a driver's dependence on maps. Motorists perhaps felt that they could get sufficient information from a map. Indeed, maps offer variety benefits such as route planning, route following and navigation/touring (e.g. Robb, 1987). In fact, previous works also reveal that maps were the preferred choice of strategy because they are more effective than the verbal means of conveying environmental information (e.g. Kirasic & Mathes, 1990).

In addition, maps could also provide drivers with a configurational representation of the route that could aids in developing a cognitive map. The cognitive map is important in terms of planning and it follows a route (Daimon et al., 1997). It enables drivers to relate their positions to those of other objects even if they are in an open environment. Thus, a cognitive map permits 'solving problem' in terms of space, such as self-orientation and it allows distance estimation. Therefore, the application of maps could bring some knowledge beforehand regarding the environment in which respondents need to get there. This prior knowledge could be store in the maps itself such as landmark which then could be used by drivers in developing cognitive maps that could qualify them to identify their target environment, e.g. cities.

Nevertheless, the use of maps raises several concerns, for instance, how such information is presented to drivers. Previous works have established the difficulty that drivers had when reading a maps (e.g. Streff & Wallace, 1993; Streeter & Vittello, 1985). In addition, drivers have difficulty in visualizing routes or matching maps with environment in front of them (e.g. Williamson & Barrow, 1994). Thus, it showed that maps are also accountable to several critical problems. For example, as apparent by Burnett (1998), the problems that drivers had when they used maps can be broken down into several aspects: failure to notice relevant information included in the maps, lack of information presented in maps and misinterpretation of maps. These are the problems encountered by drivers when travelling to unfamiliar setting using maps.

The present study also showed some other strategies that has higher percentages among the respondents. Respondents indicated that they would stop and ask for route information. The findings are also in accordance with other previous works (e.g. Wallace & Streff, 1993; Burns, 1997). This meant that in different geographical location, drivers may also used similar approach, e.g. stop and ask for directions. Indeed, this also shows that verbal means of conveying information may support a driver's progress. For example, a person who has direct and recent experience with travel in the route will be able to provide information that is not available from maps. In addition, information given by someone would differ from information acquired from maps. A person would normally provide procedural route information whereas map could produce configurational information that need to be translated into procedural route instruction for navigation.

Similar to the case of maps usage, this strategy is also subject to several problem such as perceptual confusion which referred to the lack of distinguishing features or landmark in some of the environment, e.g. in large housing development on along certain road/street. This created confusion over which is the desired location or turning. The difference of the scenario among the destination, e.g. cities, may influence the difficulties that drivers had. For instance, in cities driving, there are generally many landmarks present. Thus, the present of landmarks could help or interrupt drivers progress, It is because some drivers may not be able to distinguish some or the landmark or features in their intended cities. In addition, other problems such as environmental changes which referred to the ideas that the environment had changes in some ways since the person had last been there may also influence the outcome of the use of the strategy, e.g. drivers may not be able to reach their destination.

However, the progress of drivers by using this strategy, e.g. stop and ask someone for route information is also related to other factors such as personal experience, spatial ability and level of spatial knowledge (e.g. Stern, 1988). Indeed, Gould (1989) pointed that in a navigation-related context, spatial ability includes several elements such as attention span to spoken direction, verbal recall from previously reviewed direction which may influence the successfulness of the strategy. Thus, people with different abilities would learn spatial relationship at a different pace. Therefore, the ability of respondents in planning their trips based upon information given from someone may result in several outcomes, e.g. reach their destination or lost their way. Nevertheless, drivers may also used other type of strategy as assumed by Schofer et al., (1993) that indicated drivers would acquired two types of information, e.g. active information such as reading, asking and listening or passive information such as experiences to support their travel decision from various sources. They could use information other than they got from someone and combined it with other information in orders to plan their journey.

Respondents also revealed that they would go without any preparation to their intended destination, e.g. city. This finding is consistent with the results of Gordon & Wood (1970) works that also found some of the drivers may go without any planning/preparation. The strategy may be important if they were to combine with other strategies such as stop and ask for route information while en-route to their intended destination. Indeed, the present study clearly displayed that drivers would use more than one strategy in planning their unfamiliar trips. In this case, we could assume that drivers might not entirely depend on one strategy but would use other approach especially while en-route to destination. Indeed, Gordon & Wood (1970) have demonstrated that some of the drivers would rely on landmarks. In addition, Schoppert et al., (1968) also shows that drivers may well realized their intended destination even though they did not prepare for their journey. Thus, it may be assumed that drivers may use other types of sources such as personal experiences in assisting them. This learning through travel is a coordination of perspective (Piaget et al., 1969). This actual travel experience can enhance spatial knowledge. Thus, the use of other strategy, e.g. verbal direction or maps can improve the chances of the travellers to arrive at their intended destination.

However, this strategy may also be exposed to other problems. For example, Farber et al., (1986) and Engels & Dellen (1989) had shown that travelers who are unfamiliar with the local and/or disoriented would cause more accidents or traffic conflict than drivers who know where they are and where they need to go. This error, to go without planning may be due to inadequate knowledge of planning and this is likely to occur in unfamiliar as in familiar environments. Problems such as lack of planning because of inadequate knowledge arise when driver did not know their intended destination ought to be or what it would look like. This type of error which may be referred to 'knowledge based error', is caused by a lack of appropriate knowledge and possible strategy may induced critical decision making or actions such as making incorrect assumption about the layout of the environment.

Despite the limitation of their capabilities (e.g. inadequate knowledge), drivers have an impressive capacity to function effectively within the constraint of the representation they do have (e.g. Thorndyke & Hayes-Roth, 1983). This proved the influence of several factors on the effectiveness and successfulness of the strategy used by drivers to reach their destination. Factors such as previous knowledge that developed through experiences may affect their navigational performance. This previous knowledge which is stored in memory may help driver in planning their trips. For example, Schraagen (1990) has showed that first time travelers may have general idea/knowledge about road types, e.g. main/secondary roads even if the road is unfamiliar, they are still meaningful to a driver. Thus, this personal knowledge may assists in translating the information to become a meaningful cue for drivers to use.

The above strategies employed by both male and female drivers clearly shows that the strategy used did not differ between the two groups. Indeed, the study may be well in agreement with Burns (1997) which suggested that planning strategies did not differ substantially between the setting and environments. However, several suggestions should be taken into consideration. For example, some studies have described the difficulty in employing certain strategy when planning a trip. In fact, Burns (1997) has demonstrated that female drivers reported that maps were more difficult to handle compared to male drivers. His findings may imply that the strategy itself may well have advantages and disadvantages depending to one own self. Unfortunately, the present study did not investigated drivers' performance when they actually employed the strategy. Thus, based upon this assumption, although some of the drivers may perceive difficulties of using a planning method, it does not necessarily relate to the performance problems. Differences could mirror attitudes as much as skills.

Indeed, previous works also showed different finding and strategies were used in navigation related activity, e.g. route planning. Different findings clearly exhibit several methods were used in planning unfamiliar trips. This method may well incite drivers' performance when they actually employed the strategy. For example, previous research have shown that older drivers have more difficulties in reading maps (e.g. Aubrey & Dobbs, 1990). The differences in map reading could be caused by a lack of practice or experience (Williamson & McGuiness, 1990). In addition, past studies also showed that there are differences in gender (e.g. Hyde, 1990) and age in spatial ability (e.g. Simon et al., 1991). This implies that other factors might influence navigation performance or strategy used, e.g. age and gender. However, the present study did not found any differences in gender or age groups regarding the strategy used by respondents.

The variety of strategies employed proposed a need for more thorough investigations on route planning methods and combine them with drivers' performance when they actually used it in real life situations. Nevertheless, past studies have given some useful insights regarding the problem that drivers faced when they actually employed the strategies. Thus, there is a need to have some sort of system that is capable to reduce a variety of problems related to the use of various strategies in route planning. Taken as a whole, the above results suggest a need for a system that is capable of providing different information to suit particular navigational solution.

In order to support such 'Intelligent Systems', navigable databases would have to contain a greater range of information and information regarding the quality of such information.

In conclusion, these results imply that local drivers would rely on maps in planning their unfamiliar trips, e.g. road or cities. In addition, they also would use material from several sources, e.g. asking someone when they are close in the vicinity and by using acquaintance assistance. However, the respondents also mentioned that they would go without any prior preparation. All of these strategies suffer some kind of drawbacks. Nevertheless, it is not clear whether all the strategies affect respondent's performance when planning their trips. The findings clearly show the availability of information, e.g. strategies that could help drivers in planning their unfamiliar trips. However, one may argue the suitability of the strategies used by local drivers. For example, differences in the complexities of the environments, e.g. cities or road may affect the ease or difficulty of navigational decision making. In more complex environment (e.g. cities), it is evident that drivers perceived the need for increase use of informal, context based cues to enable navigation. Thus, maps-dependence may not be the strategic way to reach their unfamiliar destination. Thus, no wonder that local drivers would use different types of strategies even though they want to go to only one particular destination.

7.4. Wayfinding strategies

Besides route planning strategies, this present study is also interested in finding out how local drivers find their way in unfamiliar environments. Wayfinding strategies refer to the procedure people use to find their way while driving. The present results show that most of the respondents tend to report to use more than one strategy in order to help them in finding their destination. This clearly demonstrated the usage of various types of method in navigational related activities, e.g. wayfinding. Indeed, this finding is similar to those of route planning where local drivers would use more than one strategy. Thus, we can assume that Malaysian drivers may well use a combination of various approaches in navigation.

Similar to the case of route planning, respondents expressed preferences to referring to a map. For example, the most common strategies used in three different settings were map reference, stop and ask for directions, go without planning and relying on driver's own memory.

The first three strategies are correspondent with the route planning strategy. The similarities of wayfinding and route planning strategies as evidenced in this study clearly shows that drivers may well used both strategies in both navigational related activities, even though the purposes or criteria of the journey were different.

The study has found that on average respondents would use more than one strategy. Thus, it seems logical that drivers would use the same strategy in wayfinding activities as they did in route planning task. It could be assumed that using a combination of strategies could convey more information. However, one may argue regarding the differences of both activities, e.g. route planning and wayfinding which have different characteristics. For example, route planning strategy refers to before drivers actually depart to their destination whereas wayfinding is referred to en-route strategy to intended destination.

In addition, there are also some differences among the strategies itself in terms of providing additional information to drivers on finding drivers' destinations. For example, maps can provide a lot of information and drivers felt that sufficient information can be derived from maps. However, when the destinations are unfamiliar to drivers and their experiences with those destinations were limited, they do not have an opportunity to know more than what the maps offered. Thus, they may well use other kinds of approach such as stop and ask for additional information which is not included in the maps.

Indeed, this survey findings contradicted with those of Parkes & Martell (1990) and Wallace & Streff (1993) who found that majority of drivers in their survey report the use of written notes for navigation in urban areas. However, one explanation could be given to these discrepancies. For instance the differences in the subject population and the culture of driving between the U.S, U.K. and local, e.g. Malaysia. When comparing these studies, it also reflects the differences between the reported and actual behavior. Thus, a more thorough investigation is needed in order to minimize this unresolved matter.

Although maps offers various benefit, it also suffers from drawbacks such as reading it is a difficult cognitive task which involve learned rules (e.g. Streeter & Vitello, 1985). Indeed, reading a map while driving has been found to be even more difficult and is inevitably associated with high task workload with a large percentage of time spent with the eyes off the road (Wierwille et al., 1989). This has implication for the use of complex visual in-vehicle navigation systems. The system should be able to provide information, which is quick, and not to endanger the users.

However, as mentioned earlier, drivers would also use other strategy. For example, drivers were more likely to stop and ask for directions, e.g. in the cities. It is because it is more feasible; stopping may be easier and there tend to be more people around to ask. Furthermore, asking people in the vicinity of a destination may assist drivers with a particularly complex part of journey. For example, Gordon & Wood (1970) had shown that drivers would ask anybody-passerby or gas attendant in order to get to their destination.

The use of other strategy such as a passerby in conveying information to drivers may assist them to reach their destination. Previous studies have shown that human possessed two kind of spatial knowledge, e.g. procedural and survey knowledge. This procedural knowledge contained a step by step description of route from the origin to the destination, an indication of the points which directions is changed along the network, and what action is performed at these point of changes (e.g. Thorndyke & Hayes-Roth, 1982). This knowledge would help people to give information to someone and they would be able to use or follow it according to the information that was given to them.

Indeed, Mark & McGranahan (1988) have demonstrated that verbal direction provides by someone to the motorists, which are sequential in presentation form, convey information at the procedural level. In addition, Kuipers (1978) has recommended that provision of navigation information at the procedural level (verbal instruction) should be easier to assimilate than would be graphic (map-like knowledge) instructions. For example, as evidenct in Gordon & Wood (1970) study, drivers would rather ask regarding the direction to their intended destination than trying to remember an entire five or more choice points. It is because, for instance, driving in a city is likely to be more demanding on people. The city itself has higher frequency of decision points and complexity of road layout. Thus, it increased complexity of city wayfinding and could make it more difficult to memorize and recall routes.

As with other method, this strategy also suffers some drawbacks. For example, information that was given to drivers may not be the accurate one. Brooks (1968) found that spatial and verbal tasks are entirely different cognitive tasks in which it could interfere with the driver's wayfinding ability. In addition, people commonly give ambiguous, vague or incorrect directions (Riesbeck, 1980). Thus, it may restrain driver's progress in reaching their destination. Other studies also showed that the use of landmarks given by someone to motorists may not be recognize by the first time, over-stimulated travelers (e.g. Streeter et al., 1985). Thus, they may fail to find their way to the destination. Consequently, the successfulness of the strategies depends upon the information convey by the person and the driver's mental maps of the route network which is strongly dependent on his travel experience and on his information acquisition behavior. Therefore, we may conclude that although the strategy, e.g. stop and ask for directions could assist drivers, it also suffers some critical limitations. Motorists may well get laid off or lost when trying to match the information given to them by someone with the environment of their intended destination.

Another strategy which is consistent to route planning strategy describe above is that some drivers may go without any preparation. This strategy might be used in conjunction with other methods such as map reference or stop and ask for directions. Indeed, Schraagen (1990) has suggested that drivers may have general knowledge of certain routes that they once have visited. Thus, they may have certain expectations about their unfamiliar destination in general. This general information about unfamiliar destinations may help travelers to locate certain landmark (Devlin, 1976).

Previous works have demonstrated the usefulness of landmark in assisting drivers while navigating in unfamiliar settings (e.g. Burns, 1997; Burnett, 1998). Indeed, landmark serves as aids to the cognitive mapping process. As mentioned earlier, cognitive maps enable drivers to solve problems in space, such as self-orientation. However, landmarks also serve as distorting elements. Previous studies have shown that landmark may cause imprecise distance judgements (Byrne, 1979). Thus, landmark usage could either assist or impede a driver's progress.

The present study revealed that there were no differences between gender and age group regarding wayfinding strategies especially when going without any preparation/planning. The present study shows that both genders would employ the same method, indicating their capability finding their intended destinationa. However, it is unknown whether they are able to find their destinations or they used it with other types of strategy, e.g. refers to maps. Thus, this finding can be questioned in terms of the successfulness of the strategy in achieving their goal. Nevertheless, past studies have shown that travelers succeeded in finding their destination even though they did not prepare for the trips (e.g. went without planning; Schoppert et al., 1960). This may be due to the extensive knowledge or travelling experience in the part of travelers. For example, the hierarchical nature of spatial knowledge allows people to infer relationship, for instance between two routes. Nevertheless, this process of inference sometimes lead to errors.

This error occurs when the location of routes has been normalized. This normalization is a familiar type of error in people's spatial representation (e.g. Stevens & Coupe, 1978; Chase & Chi, 1981). Nevertheless, Kaplan (1976) argued that drivers would explore a learning process which will lead to confidence and a feeling of comfort when exploring natural setting even if they were unable to find their way to their intended destinations. This may suggest that inability of travelers to find their way to their destination may help in forming some knowledge regarding the place although it was not their intended destination.

However, it is a pity that the present study did not measure the effectiveness of the method used by drivers in finding their way. Still based upon previous research, it showed that drivers reported negative feeling when lost (e.g. Streff & Wallace, 1993; Burns, 1997), perhaps due to their lack of preparation when making these unfamiliar trips. This is a further evident highlighting the consequence of wayfinding problems, especially when travelers fail to get to their destinations.

Respondents also indicate that they rely on their memory when trying to find their way to unfamiliar destination, e.g. cities. However, one could argue the suitability of relying on memory for city navigation. It is because the task of driving in a city is likely to be more demanding on drivers. Higher frequency of decision points and complexity of road layout in the cities could make it difficult to memorize or recall routes. Consequently, relying on memory would be a less effective strategy in cities. It is because travelers have to obtain detailed information that is not available on large-scale maps (if drivers studied the route from the maps earlier).

Nevertheless, one could assume that respondents may use a combination of other strategies such as stop and ask someone for directions whenever they could not recall the information stored in their memory. Thus, it was postulate that drivers in this present study may well used different kind of strategies or more than one strategy in assisting them in finding their destination.

By relying on their memory from planning and studying the route or destination (e.g. from various sources) in order to find the way was in fact a dynamic affair. It points to the behavior and to the cognitive processes involved in reaching a destination. Indeed, many people moving around on highways, route in the cities and in complex building may well know what they have to do to get to a destination, but they do often ignore where they are in relation to the space surrounding them (Passini, 1981). In other words, people were quite efficient in terms of wayfinding although they are not spatially oriented. This implies that travelers may well search for their destination with the usage of various types of approach.

As mentioned earlier, there were no differences in term of age and gender regarding the usage of this strategy of wayfinding. This may imply that both factors did not play an important role in influencing the kind of strategies to be used. For example, wayfinding in an unfamiliar city could be considered as a form of problem solving. Both drivers, e.g. male and female perhaps felt they did not have clear picture on how to reach his/her goal, although they already memorize some detail planning regarding the cities before departing. According to Schraagen (1990), travelers may use heuristic search, i.e. they would use information stored in their memory to choose more promising over less promising routes. However, this strategy is slow and likely to err. This is because the information has to be held in the working memory in order for the weak methods to be able to match it.

The strategy such as relying or memorization of certain portion of maps, or acquiring verbal directions from someone could assist travelers. This general knowledge about cities and other destinations may help them to locate certain landmarks. Indeed, first time drivers to a new city not only know where certain landmark are but also have general knowledge about road types

(Schraagen, 1990). In addition, Elliot & Lask (1982) found that first time drivers prefer to stay on the major roads as long as possible and only move to a more local road type when it is absolutely necessary. Thus, it may suggested that first time drivers may well have the general knowledge regarding their intended destination even though they did not have adequate knowledge about it.

Similar to other strategy, it also liable to some critical limitations. For instance, driving itself is an attentional demanded task in which in turn relies on memory to do the task. Hence, it seems that by relying on memory, travelers have to divide their attention, e.g. one for driving and the other for navigational activities. In fact, previous studies have demonstrated that a significant portion of drivers' attention was directed from the roadway under dual task conditions, particularly as the auxiliary task became more difficult (e.g. Noy, 1989).

Driving, for example, in the cities will involve both macro-level wayfinding as on major roads and micro-level destination pinpointing. One of the causes of wayfinding mistake is the constraint on drivers information processing. This information processing could fail in many ways such as limitations on attention, working memory, logical reasoning and decision making (Wickens, 1990). In this wayfinding case, mistakes could occur when drivers are lacking in cognitive resources available to make a decision. This may happen when drivers are occupied with the priority of maintaining safe control of the vehicle and does not have sufficient spare attention to devote to a secondary task of a wayfinding. Thus, local drivers would employ other strategy in findings their way to their target destination. For example, by combining a map or ask someone in the vicinity in order to support the information stored in their memory regarding their intended destination.

The results clearly showed that various types of strategies were used in wayfinding activities in three different settings, e.g. city, highway and road. Although, these settings were different in terms of route network and environment, drivers would still use the same strategies, perhaps on the nation that they could get sufficient information to assist them in reaching their destinations. Nevertheless, the usage of more than one strategy by local drivers clearly demonstrated the need for more information that could be use as guidelines for drivers. Indeed, the intended information system, e.g. route guidance system should be able to provide various kinds of information/strategy or cues to be used by motorists. However, there is still a lot of problems need to be resolved before the intended information systems are developed. For example, the suitability of particular information types or strategy to be used by drivers should be investigated before designing the information system. In addition, the reliability of the information or strategy in informing drivers while finding their way to their destination. Finally, the issue of format and the timing to present the information would be one of the important tasks that need to be studied thoroughly by ergonomists.

As a conclusion, maps were the main strategy used by local drivers for wayfinding in unfamiliar destinations. However, the present study also stressed the usage of other strategies by drivers in navigation related activities. Drivers were reported to use more than one strategy, i.e. a combination of other strategies in finding their ways to their intended destination. Taken as a whole, these results, e.g. route planning and wayfinding imply that drivers would use maps. They also would use other strategies which suggest that they did not stick to only one approach but they would use several approaches when navigating to unfamiliar environments. Each strategy has it own advantages and disadvantages. Therefore, there is a need to further investigate these issue, e.g. navigational strategies especially in regards to local drivers in order to develop some sort of systems which could assists them. This study is the first that investigate drivers' navigational strategy in Malaysia; thus, the generalization of the finding should be made with caution.

7.5. Route choice criteria

Another aim of this study was to explore the criteria that drivers employed when selecting a route to a particular destination. This study was developed based upon several previous works such as Benshoof (1970) and Wachs (1968). The study provides an insight concerning the criteria that local drivers perceived to be useful in determining what route to use in three different settings. The present study clearly described that different criteria were used for selecting a route in different types of journey. This finding suggest that local drivers may apply different set of values when applying these criteria in selecting certain route.

Home to work trips

The findings demonstrated that at least five types of criteria were thought to assist motorists in influencing their route choices. The five criteria that were considered important for home to work trips are safety, time saving, less mileage, certainty of arrival time and avoiding congested route. The result clearly indicates that drivers would employ various types of criteria in route selection. This results is in agreement with other previous studies that also found the usage of variety of types of criteria by motorists in selecting a route for certain types of journey (e.g. King, 1986; Abdel-Aty, et al., 1997).

Indeed, these criteria could be interpreted as time constraints in which drivers have while commuting to work. The results have demonstrated that drivers highly valued the importance of less mileage, time saving, safety and other criteria while commute to work. These criteria might explain the reason behind employing a certain approach in choosing a route. Drivers need to be at work on time. They need to avoid penalty of arriving late at work. Thus, the criteria selected could be suitable which could help to achieve this goal of reaching the destination on time. In fact, the criteria used were concordance with the journey purposes. This result may suggest that trip purposes might influence a driver's route choice process. Indeed, the result is also consistent with previous works that found different criteria used were related to the nature of the trips made by drivers (e.g. Stern & Leiser, 1989). They found that criteria used by drivers in Israel were related to the trip purposes that drivers made. This may suggest the relationship of the trip purposes in influencing driver's route choice criteria.

However, one could imply that various factors are present in a driver's decision when formulating a route, such as travel time, traffic safety, distance and number of intersections. Moreover, Abdel-Aty et al., (1997) also suggested that drivers' experiences, habits, cognitive limits and other behavioral considerations may produce variations in route selection. Thus, it was suggested that the above factors might well influence drivers' decisions when selecting a route. For instance, Van Winsum (1993) reasoned that route choice criteria were not independent on each other. This clearly shows the influence of other factors on these criteria. Consequently, the reasons for choosing a given route are affected by the advantages and the disadvantages implied by the characteristics of the travel mode.

For home to work trip, the result has highlighted the need of drivers to use a route that could reduce travel time uncertainty, mileage and maximizing safety and reducing commuting costs. For example, Noland (1997) perceived that uncertainty travel time could result in arriving late at work, which may involve significant cost. Thus, one of the alternative that drivers often do is they generally modify their departure of schedules to minimize both the cost of travel time and the costs associated with schedule delay, especially late arrival. Thus, there is a need to give accurate information that drivers could use in selecting a route that is capable of minimizing travel time uncertainty.

Previous studies also demonstrated the use of various criteria in selecting a route (e.g. Cross & McGrath, 1977). Indeed, some previous works even suggested that saving time, e.g. minimizing travel time is considered as the most important criteria affecting route choice (e.g. Duffell & Kalombaris, 1988). In fact, Dufell & Gordon (1983) also found that motorists would put high on their list criteria such as minimizing perceived journey time, delaying stopped time and perceived journey costs when selecting a route. Thus, it is clear that local drivers stressed the need for time saving, avoiding congested route, and certainty of arrival time in order to reach their destinations.

Taken as a whole, the results imply that there were several factors/criteria used in choosing a certain route for a certain type of journey. Indeed, other studies also arrive at the same conclusions that motorists used various types of criteria. Thus, we could conclude that local drivers would select a route to use depending upon their journey purposes, e.g. go to work. They need to be on time at work in order to avoid late penalty at work. The findings could be used by system designers in developing some systems to help drivers in route selection. For example, the systems should have various criteria or information to be used by its end users. In addition, the systems should also complement a driver's knowledge if they have complete knowledge of the characteristics of the routes. It is because drivers may argue the capability of the systems if they have complete knowledge regarding a route compared to the systems. Thus, system designers should be able to distinguish the need of different category of drivers; e.g. novice vs. experienced drivers.

Apart from driving experience classification, the study also showed that there are significant differences between the age group of local drivers regarding the criteria of route selection. For example, the finding shows that older drivers regarded safety as the main criteria compared to other age groups, e.g. younger or middle age groups. This may suggest that older drivers are more careful in selecting a route than other drivers, Safety is the main criteria for majority of drivers in route selection. However, in this study, older drivers seem more concerned compared to the others. This may suggest that other drivers may not consider safety aspects as the most important criteria in route selection, Nevertheless, this assumption can be argued because there is no study that could support this claim. In addition, the survey has shown that most of the younger drivers (below 25 year of ages) prefer to increase their commuting safety. Therefore, the findings should be interpreted with caution. It is because the limited number of older drivers participated in this survey. In fact, the number of older drivers in Malaysia is quite small or they may not drive at all. However, the findings could be useful in developing a plan in assisting older drivers in route selection.

Work to home trips

The five criteria which were considered capable in influencing drivers' route choice for work to home trips are safety, lessmileage, the avoidance of congested route, fastest route and less traffic. These various types of criteria used by drivers suggested the need for information system that is able to employ or contain such criteria in order to assist drivers in choosing a route. There are some similarities regarding the criteria used in different types of journey. For example, drivers would employ safety, less mileage and avoiding congested route. Thus, it indicates that these criteria were important in influencing drivers' decision to choose a certain route to use.

In fact, a closer inspection of the results suggests that these results should be interpreted with some caution. For example, as similar with the first trips, e.g. home to work, safety was the important criteria that drivers would use. This clearly demonstrated that local drivers highly value safety aspects in any commuting trips. Thus, demands for safety is logic. The rush hour congestion - morning or evening seemed to be one of the main motivator of drivers changing routes (e.g. Caplice et al., 1991). Thus, it was suggested that safety could influence motorists whether to choose a route, e.g. whether the route is safe or not.

The other criteria that were similar, e.g. less mileage and avoiding congested route clearly showed the similarity of criteria used in two different trips by local drivers. This demonstrated that some drivers might be well acquainted with the factors, e.g. criteria used in selecting a route. This indicated that the same criteria were used in two different settings. However, these findings were not concordance with the other previous works (e.g. Stern & Leiser, 1989; Wachs, 1967) that found drivers would used different types of criteria for different types of journey. The differences in findings among the studies perhaps resulted in the different manner of the study were conducted. For example, Stern & Leiser used different method (e.g. open-ended questions) compared to the present study which used closed ended questions that provides a variety of criteria that drivers use in selecting a route. Thus, it was thought that different method used might resulted in different findings. Nevertheless, this study clearly showed that different types journey may evoked the used of the same criteria even though in different settings.

The results suggest that drivers would use the same criteria as they did in home to work trips. This demonstrated the importance of these criteria in affecting a driver's route choice. Perhaps, they have good knowledge regarding the route that they would take. Thus, systems designers need to focus on this issue, e. motorist's knowledge regarding route network. The system should be able to provide accurate information or criteria to its end user. For example, the system should provide information such as congestion in order to assist drivers by avoiding congested route.

The results also show that drivers would like to save mileage in these trips to home from work. This finding is in agreement with Duffell & Carden (1983) who found that drivers would try to minimize journey length (to save mileage) in order to optimize their journey in most circumstances. By minimizing distance, they would be able to arrive at their destination and able to minimize travel time. Indeed, some study shows that drivers would employ saving mileage criteria in order to choose a route (e.g. Trueblood, 1952). However, the criteria are related to other factors which could influence a driver's route selection process. Factors such as congestion on their intended routes and departure time certainly will influence drivers' route choice. For example, congestion on their intended route could cost them in terms of fuel wasting. Thus, they would choose other route that could save their journey, in term of time and distance.

Thus, it can be suggested that local drivers would select a route in terms of time, distance and safety. It is also similar to the findings of Van Winsum (1993) that found total travel time strongly influences the preference of the route. However, one may argue that other factors also affect drivers' preference of the route. For example, Abdel Aty et al., (1997) found that experience with the route influenced motorists to continue to use/select the route even though they have an alternative. In addition, Dudek et al (1982) also demonstrated that some drivers might not want to change route even though the suggested route is better than their regular route. Nevertheless, we could suggest that route choice process is a very delicate process. Drivers need to consider all alternatives before finally choosing the route. For example, in this study, drivers would only select the criteria which applicable to them (e.g. safety, saving mileage etc) in order to arrive at their destination. However, as popularized by Hall (1983), drivers also could make some alteration while en route to their destination. This process is called 'adaptive route choice'. This process enable motorists to change their criteria depending upon the problem that they faced while en route to home or other destination. Thus, drivers may well divert to other route if they found that their regular route is congested.

Indeed, it is believed that the above results reflect the suitability of the particular criteria to be given to drivers in selecting a route for work to home trips. For example, saving time & mileage, safety, and avoiding congested route should be installed in the future information systems databases. However, there exist several problems concerning the presentation of the criteria to the users. For example, what kind of information should be given to drivers and in what format? Thus, more research is needed to resolve this issue.

Statistical analysis shows that there were significant differences between gender and age groups concerning criteria that drivers used in route selection for work to home trips. For example, differences between gender revealed that female drivers preferred to avoid congested route than their counter part, e.g. male. This may suggest that this criterion was perceived as important for female than male drivers. This finding may imply that female drivers did not like the idea of being stucked in a congested route especially during rush hour. However, one may argue because not only the females do not like to the idea of being trapped in a congestion but so do the male drivers. Thus, this result should be interpreted with some caution.

In addition, older drivers also preferred fastest route criteria compared to other age groups. This may suggest that in work to home trips, this group want to be on time at home. Thus, they would choose the fastest route in order to reach their destination. Compared to from home to work trips, the older drivers preferred safety as the main criteria in choosing a route. This may suggest that they would use different set of criteria for different type of journey purposes. Wachs (1968) also suggested that people preferences for route characteristics do vary and it can relate to the characteristics of travelers, their trips and route to which they have been exposed. Thus, it may be suggested that older drivers have good knowledge on the route because they are experienced drivers compared to the others.

The above results shows that different group of drivers (in term of gender and age groups) may employed different kinds of criteria in selecting a route to a particular destination. It is believed that the above result was concordance with the previous works such as Bovy & Stern's (1990) which suggested different criteria were used in route selection. Indeed, drivers would also use different criteria or values in route selection. For example, male and female drivers may specify different valued toward the 11 criteria stated in the questionnaire. Female drivers would like to avoid congested route because it could save time in several ways in terms of time, distance and fuel consumption. The study clearly shows differences between the male and female drivers regarding the criteria that they would use in route selection. However, the findings should be treated with caution because there is no reported data or study to compared with. In addition, the results may not represent Malaysian motorists' route choice criteria.

Unfamiliar trips

With respect to driver's preferences for route selection criteria that they would use for unfamiliar destination, safety factor was ranked the most important with 65% of subjects ranking it as their first choice. The second choice was less traffic followed by avoiding congested route, less mileage and good traffic flow which were rated favorably in terms of its importance. Given the fact that this was an unfamiliar driving situation, the results seems to be or considered to be extremely important for choosing a route for unfamiliar trips. For example, in three different settings, e.g. home to work, work to home and unfamiliar trips, safety was most important criteria that subject rated in those settings. Thus, it clearly demonstrated the need for safety route to use by local drivers especially in three different situations. Safety would be a paramount criterion to be used and influence travelers in the process of route selection. Thus, the safety criteria is important particularly when drivers are not familiar with the route network of the destination.

Indeed, the other criteria also could be influence by the presence of safety criteria. For example, less traffic, avoiding congested route, less mileage and good traffic flows also might influence drivers' selection of route to unfamiliar trips. These criteria may be related to each other. Thus, the characteristics of the route itself could play a vital role in influencing driver decision.

As evidenced by Benshoof (1970) and Wachs (1968), travel time was one of the important factors that were used by drivers in selecting a route. Thus, one may suggest that, in three different settings, the criteria used by local drivers might be related to 'time factor'. It is believed that the above results also reflect the driving culture of local drivers, e.g. they seemed to be in a hurry in order to arrive at their destination (e.g. Dewan Masyarakat, 1992). The fact that various type of criteria were used in route selection process confirmed previous works findings that demonstrated the usage of variety of factors in influencing drivers decision (e.g. Abdel-Aty et al, 1997). With regard for each settings/situations; several criteria were found to be used more frequent than others. For instance, safety, avoiding congested route and less mileage were requested frequently in route choice process.

Nevertheless, these findings also differ with several previous works such as Bovy & Stern (1989)'s. The differences were perhaps based upon the different method employed by theinvestigator while studying the phenomenon. In addition, the study was the only/first of its kind in the local scenario that the result might be tentative compared to others which have already been done in the past years. Moreover, one could argue by saying that in a local environment, these factors were more constantly used by local motorists in selecting a route in three different settings. However, one question remained as these responses may not be the accurate answer or criteria used by local drivers. It is because there is differences between "reported" use and "would" use (e.g. stated preference) (Parkes & Ashby, 1991). Thus, the findings should be treated with caution.

Nevertheless, the study has revealed some interesting findings concerning the criteria that motorists would use in route selection. Indeed, it is important to remember that the trip is unfamiliar to drivers. Thus, criteria such as safety and saving mileage are critical/important to them. In fact, similar to the case of navigation activities, drivers would use more than one strategy in order to arrive at their unfamiliar destination. Therefore, it seems logical that drivers would employed criteria that are relevant to their trips purposes.

The results of statistical analysis showed that there are significant differences between the age groups regarding several criteria for route selection. For example, older drivers preferred safety and less traffic as their main criteria to select a route when travelling to unfamiliar destination. This may suggest that these two criteria are important in assisting older drivers in selecting a route. It is because drivers did not know exactly the nature of their target destination. Thus, it is no surprise that they prefer to select a route that is safe for them. However, their expectations regarding the choice factors may be inadequate. It is because the number of available alternative is large that drivers cannot be expected to compare all of them as to the aspects that are relevant to him. Thus, drivers may prefer only the two of many criteria in selecting a route to unfamiliar destination.

In conclusion, it is believed that the findings of route choice criteria in three different journeys clearly showed that respondents ranking or preferences varied. Other factors such as trip purpose and driving experience might influence drivers' ranking of route choice criteria. In addition, the findings clearly exemplify the difficulties in arriving at universal conclusions about the relative importance of choice attributes/criteria for several trip purposes, Furthermore, the results shows that in different types of journey, different criteria were used. Moreover, the use of variety of types of criteria justified the assumption that drivers did not use route based only on one criteria (e.g. Wachs, 1968 & Benshoof, 1970). The study also shows that driver's characteristics, e.g. gender and age may play a role in influencing route choice selection. However, many of the previous works did not address these issues (e.g. differences in age and gender) concerning route choice criteria.

Nevertheless, the survey regarding drivers route choice appeared to be able to provide new information for the Malaysian government and the respective agencies concerning the plan for improving drivers' decision making for selecting a appropriate route. In addition, the study contributes to the knowledge of route choice criteria used by local drivers, especially commuters in selecting routes for several types of trips. However, there were no studies reported so far regarding the criteria that drivers used in selecting routes in several journey types especially in Malaysia. Thus, the study provides some new findings and knowledge regarding route choice criteria used by drivers. The study shows that drivers would use various criteria in selecting a route for several types of journey. The criteria that drivers use might be related to their trip purposes.

7.6. Information Requirements

The original aim of the study was to investigate what kind of information that local drivers want in several types of journey purposes. Indeed, it is clear from the results (e.g. Table 6.11 to Table 6.18) that a wide range of information were required for different types of journey purposes. The following sections discuss in detail the results of this study with regards to different information requirements.

The result indicated that motorists would require more than one type of information for a particular type of journey. For instance, it is evident that when travelling to work from home, information required is differed from travelling to home from work, However, the findings also revealed that at least five types of information were needed for certain types of journey. This result demonstrated the variety of types of information required in assisting motorists in several types of journey. Indeed, it is also in agreement with other studies, e.g. Penttinen et al., (1996) and Streff & Wallace (1993) that revealed the need of variety of types of information for different set of journey or settings.

Indeed, such findings also are in complete agreement with other works such as Tsai 's and partly reflect the differences in the requirement of information across driving environment/settings. For example, in home to work commuting trips, information that respondents wanted were congestion, route guidance, alternative route, parking guidance and traffic state prediction. Whereas in Tsai (1992) study, he found that motorists would like to have information on congestion and alternative route. Thus, we could assume that congestion and alternative route were important according to drivers' preferences.

In addition, the study also revealed some similarities regarding the information that drivers required for several types of journey. For instance, respondents listed similar types of information even though in different types of journey, e.g. home to work and work to home. These information demonstrated the similarity and importance of the information to drivers. It is likely that the primary basis for this result is related to the nature and the complexities of the environment which affects the need of that information.

Not only there is a similarity regarding the information needed in home to work and vice versa, the study also revealed a similarity on the information requirements in other types of trips. For example, regarding congestion information requirements, e.g. home to work and vice versa, drivers would prefer to have information such as condition of congestion, location of congestion and alternative route on both trips. Thus, it meant the importance of these information in influencing drivers' decision.

Moreover, in other two situations, e.g. information required when deciding whether to divert to alternative route and when driving to unfamiliar destination, the study demonstrated some of the similarities between the trips regarding the information that drivers required. This clearly shows the usage of the certain information which were thought to be important/useful to motorists. Indeed, the frequently required information may be an indication that the drivers perceived the need of these information to be included in the future motorists information systems with a variety of types of information be stored in the them.

Despite the study revelation of similarities in information needed by drivers in several different scenario, the results also demonstrated that drivers with different driving experiences (i.e. whether or not the respondents have had experience travelling to unfamiliar destination) also would reflected the same information especially for unfamiliar trips. Thus, it could be said that driving experience did not play an important role in determining what kind of information does a motorist need. This finding may be in contradiction with other investigators' results. For instance, Mannering et al., (1995) clearly indicate that driving experience may well play an influence in motorists information requirements. These discrepancies of findings would perhaps have resulted in how the studies were conducted. In Mannering study, respondents had already experienced the so-called intelligent systems, whereas in the present study, there was clearly no system available for the use of local motorists. Thus, drivers would only comment on what they thought were appropriate for them.

The present study also suggested that drivers would like to require more information rather than a single value information. Indeed, the findings imply that there should be some adaptation in the presentation of information by the information systems to cater to the variety needs of information for different driving situations. Information that drivers required for different setting certainly would assist them in those situations.

In fact, previous works especially Penttinen et al., (1996) and Streff & Wallace (1993) stressed the variety of types of information that drivers need for different trip purposes. However, some of the information was quite similar to those indicated by local drivers. A similar argument also has been put forward by other investigator such Daniels (1977) and Tsai (1992) that demonstrated various need of information by drivers in Chicago and Canada respectively.

Indeed, the results also confirmed/support previous works findings such as Ashby & Parkes (1993) that revealed drivers population itself is not homogeneous, that their need, capabilities and expectations should dictate different information provision which in turn should dictate different media and styles of information presentation. Moreover, based upon McRuer et al., (1977) classification of driving task; in each of this task - navigation, maneuvering and control need different set of information. Thus, it seem logic that based upon the above premise, drivers actually required more information and this vary in terms of their quality and quantity. In fact, the variety of types of information required in this classification of driving task justified the findingsof the present study that showed drivers required more information for different driving scenario/purposes.

As mentioned earlier, there are some similarities regarding the information required by motorists in those settings. This clearly demonstrated the important of this information to drivers, e.g. that could influence their decision. However, one argument was raised from these findings. The need of various types of information may prove to be difficult for drivers to observe. Traffic information itself is abundance with information that may expose motorists to many problems.

Based upon Miller (1956) premises that human could only get to home 7 $\pm$ 2 bit of information at one time may impeded their function/task while driving. Indeed, the ability of drivers to recall or detect traffic information largely depends upon several factors such as the length of messages (e.g. Liable, 1989). Thus, by providing more information could perhaps endangered motorists' lives than assisting it.

Therefore, giving too many information (e.g. at least five different set of information in different set of journey purposes) may be quite misleading (e.g. environmental gives different information and the so-called intelligent systems give different information). This could increase drivers overload (e.g. Rothengatter et al., 1993). However, insufficient information might also lead to other serious problems. For example, Axhausen et al., (1994) found that insufficient information regarding parking facilities has resulted in time wastage for drivers. As indicated earlier, various types of information may also overload driver's information channels. They may not be able to decide effectively. Thus, failure to allocate enough resources in optimum may increase the risk of distraction.

Indeed, several factors need to be studied in relation to the information requirements such as content and format of the information to be presented to drivers. For instance, Rumar (1988) categorized information into four types such as static, semi-dynamic, dynamic and predictive that have different functions and capabilities. Thus, system designers need to carefully investigate these issues before developing the so-called intelligent systems. These results clearly demonstrated several issues that need to be taken seriously before the intelligent systems goes into production line. The present study findings suggest that the various types of information are required. Therefore, the system should be able to distinguish different needs of different motorists in different journey.

The requirements of various types of information also raised several concerns such as how such information is to be presented to drivers, e.g. this issue is related to the format of the information (i.e. type of display). Directly, there are many types of displays used to present the information needed by drivers. The present study shows that most of the respondents prefer to receive information from commercial radio (e.g. verbal mode of information presentation) compared to other types of systems such as CB radio, RDS-TMC, VMS and others. This implies that local motorists would prefer verbal mode than visual types of information presentation.

Nevertheless, these results should be treated with caution. It is because many of the systems reported in this study has never been used or investigated by other researchers in Malaysia. Thus, the finding is tentative depending upon what other researchers found in regards to the type of mode to present the information to drivers. It is known that information that drivers required could be given by using various types of mode or systems, e.g. verbal, visual, map or combination of these mode. However, different findings have suggested different kind of mode to present the information. For example, Streeter et al., (1985) indicate that verbal messages was superior over visual information. Indeed, Spyridakis et al (1991) also suggest that broadcast sources of information are by far the most commonly used traffic information. In addition, Streff & Wallace (1993) also found that drivers rated commercial radio (e.g. verbal mode) highly important and useful in terms of giving information. Moreover, previous studies have demonstrated that verbal messages is good at getting the attention and at communicating simple information (e.g. Spoerri, 1993). All of these studies clearly demonstrated the superiority and advantages of verbal mode of information presentation. However, as evidenced by Spoerri (1993), verbal mode is good at communicating simple messages or information, whereas in this present study, most of the information is complex. Thus, it may overload driver's attentional resources and may impede instead of assisting them.

Indeed, other studies also demonstrated different findings. For example, Srinivasan & Jovanis (1997) indicate that most of the information needed for the driving task is obtained visually. Thus, it is appropriate to present the information visually by using visual types of display. Presently, the visual type of display can be broken down into two types - in-vehicle information systems and VMS. However, both systems were not available in Malaysia. Hence, the response made by local drivers regarding their preference toward the systems that should present the information must be treated with caution.

The purposes of an in-vehicle systems is to present drivers with necessary information for drivers' to make decisions in the vehicle. In addition, VMS - Variable Messages Signs could be presented to drivers outside the vehicle. Both systems presented the information visually to drivers. Previous works have illustrated the advantages of both systems in presenting several types of information. For example, Dudek et al., (1978) found that VMS messages was capable and effective in diverting freeway traffic to alternate route.

However, different findings from the previous studies and the present study results imply that there is an urgent need to investigate further and carefully regarding the suitable mode of information presentation. Indeed, it is also believed that the above results and previous works findings reflect the suitability of particular information types for presentation within a specific format. Some of the types of information were quite good in verbal mode as evidenced by Van Winsum (1987), while others simply indicated the superiority of visual combined with verbal or with map in presenting the information (e.g. Liable, 1989; Pauzie & Anadon, 1993). In fact, Srinivasan (1997) has proven that combination of visual display and verbal messages were associated with lower workload compared with the systems with only have visual display. These findings clearly demonstrated the need to further investigate this matter before developing the so-called intelligent systems.

Nevertheless, one question arises regarding the findings. At least five different types of information were required in several different settings. This matter could bring more harms than benefits to motorists. For instance, the inability to divide attention between driving and information processing (i.e. attended to messages/traffic information whether it verbal, visual, map or combination of these mode) would force one of the tasks to be neglected. Indeed, if the messages were presented by using visual display, drivers may take off their eyes from their actual driving task. Perhaps, if the messages were presented by using verbal display, there should be repeated it if drivers did not get it the first time around.

System designers then must concentrate and resolved these issues. One of the factors that need to be taken seriously is to ensure that users attention is not diverted from the primary task in order to pay undue attention to the device or the information it is attempting to convey (Galer, 1994). The present study also revealed the variety of needs of traffic information by drivers in different set of scenarios. Thus, system designers should be able to distinguish the need of various types of drivers and different capabilities in processing the information. In fact, based upon Miller (1956) premise that human could only processed 7 $\pm$ 2 bit of information at one time should be employed in developing the intelligent systems.

Despite the recently developed information systems that were put into vehicles, designers have forgotten the users who required the information. Thus, the aspects in the users' need to be investigated just to ensure that they are capable of operating the systems. For example, Katteler (1995) have suggested that sometimes it is difficult to operate RDS-TMC than the conventional method. Thus, system designers must be able to resolve this argument before setting to develop the user-friendly information systems.

As mentioned earlier, information that drivers required is related to other aspects such as the type of display to present the information and the appropriate timing of conveying the information. These interrelated issues need to be resolved by system designers before the so-called intelligent systems goes into the production line.

The present study revealed that there was indeed various set of timing to present the information for different set of journey. Indeed, the subjective preference by respondents demonstrated the need of information systems that are capable in determining, distinguish and able to present the information to the various type of drivers with different perception, vies and attitudes. This present findings proved that there exists a relationship between the nature of trip those drivers undertaken and the set of timing of the information to be given. The findings is concordance with other previous works such as Spyridakis et al., (1991), Mannering et al., (1995), Tsai (1992) and Streff & Wallace (1993). This clearly showed that previous studies also came at the similar conclusion that different type of drivers and trips purposes would also required different set of timing to present the information.

For example, if the information was needed before the drivers depart to their destination, the information may be served as an advance warning as it assist drivers in deciding the time (.e.g. departure time) and mode of transport to be used. However, with too many information (e.g. at least 5 different types of information), it is clearly beyond human control to observe and detect the information simultaneously in order to be informed regarding the current traffic situation. For instance, the present study described that in deciding to divert to alternate route, some information were required before departing and some information were required during driving. Thus, it could interfere with the driving task instead of giving benefits to drivers. If the information were given too early than expected, there must be some mistakes on the part of the drivers (e.g. Graham & Mitchell, 1997). Therefore, the timing of information to be presented may influence drivers' decisions and the need of information in order for drivers to make decision.

The timing of presenting the information is one of the important aspects that need to be investigated further and carefully. For instance, if the information was given early, it could serve as advance warning. However, other problem also arises, if the information was given too late. In fact, other factor such as memory recalled also can influence driver decision. When given the information early, sometimes drivers have to recall the information. It might bring the problem of divided attention. As evidenced by Noy (1989), motorists may not be able to divide their attention on two tasks at the same time.

As mentioned earlier, the present study revealed the requirements of different kinds of information that has different set of timing. This may involved other problem, e.g. retention of the messages by drivers. Furthermore, the optimal timing of information will vary according to their information content (e.g. Graham & Mitchell, 1997). Thus, drivers may have difficulty understanding the information or they may forget the message entirely (e.g. Graham & Mitchell, 1997). Hence, the appropriate timing of presenting the information is critical to a system that is capable of distinguishing and presenting the various type of information based upon drivers' needs, and journey as well as the timing requirements.

The timing requirements of presenting information in several situations raised several issues concerning the exact nature of information to be presented to drivers. For example, whether the information should be given in 'full' or 'half'. These issues need to be resolved. For example, if it given in 'full', drivers may forgot some part of it. Whereas, if it given 'half', it could involve redundancy of instruction or messages. Conversely, the timing of presentation of 'full' or 'half' of information may reduce drivers' confidence in the working of the system. Road trials are needed to resolve such issues.

A further issue concerns of modality used for the timing of information presentation. The presentation of information such as congestion within the auditory modality at different set of timing may create unacceptable demands on a drivers' memory, especially when length of thecongestion is long. It will also be important that messages are spoken in a way that is consistent with drivers' expectations. In addition, it is also paramount in relating the nature of messages to be given and the timing to present the messages to drivers. Simple laboratory trials could identify more specific requirements for issues such as this.

Indeed, the present findings also demonstrated the need for various types of information. This may influence the ability of the driver to recall messages which is affected by the length and types of messages, and the length of the retention period. These factors certainly will influence a driver's comprehension toward the messages that were given to him. This may suggest that the three important questions - what kind of information does a driver want, how and when to present the information were related with each other. In addition, different categories of drivers, e.g. male vs. female, older vs. younger drivers may have different preference toward the information, timing and mode to present the information. Thus, these issues need to be examined further by system designers. Indeed, this study findings confirmed the findings of previous works, e.g. Barfield et al., (1993) and Mannering et al., (1995) that proved drivers population itself is not homogeneous in term of their information requirements.

The variety of types of information and set of timing may bring problems to different categories of drivers, e.g. older vs. young. As evidenced by Craik (1977) that older driver faced a problem in dividing their attention between memory task and the primary task of safe driving. Indeed, the Miller (1956) treatise should be applied when presenting different types of information to drivers by using different mode of information presentation at different set of timing. The maximum capacity of working memory was 'seven, plus or minus two' chunks of information given full attention. It must be noted that this capacity will be reduced by the simultaneous task of driving.

As mentioned earlier, the optimal timing of messages will vary according to their informational content. A message in fact was various in types. For example, purely informative messages need not to be retained in full by drivers. Whereas, information that need definitive actions at a specific point, must be provided close enough to the events for the drivers to act accordingly. These issues need to be taken into consideration before developing the information systems.

As a conclusion, the results revealed several interesting insights. For example, various types of information were needed for different types of settings. In addition, there are some similarities of information needed in those situations. This proves the important of some information in assisting a driver's decision. Moreover, the issues of appropriate mode to present information need to be resolved and investigate thoroughly. Although, the present findings clearly illustrated drivers preference toward commercial radio, e.g. verbal types of mode, the result does not clearly showed that this mode is better than others such as the visual are. Furthermore, previous works have demonstrated different conclusion regarding the mode of information presentation. Finally, similar with the case of information requirements and mode of presenting information, the issue of timing of presenting the information also revealed the variety of respondents' preferences. Different settings which required different set of information that drivers need also influence different set of timing to present the information. However, similar to the second issue, e.g. mode of presenting the information, the findings is tentative depending upon what other local investigators found. Nevertheless, the findings were clearly in agreement with the notion that mentioned drivers population has not homogeneous in terms of their information requirements.

Individual Differences

There were differences between gender and age of drivers regarding the information that they required for work to home trips. The result of Kruskal-Wallis showed that there are differences regarding respondents' preferences toward the information on congestion between male and female drivers. This may suggest that where female drivers are concerned, they ranked this information higher than the male drivers would. In other words, we could suggest that the congestion information was demanded heavily by females rather than males. The information could offer several facts/messages such as condition and others that could be used by drivers in assisting their driving task.

Such gender differences show that the system designers should be able to distinguish the needs for different type of drivers in order to present the information to its end users. The underlying reason/s behind the result could be that female drivers perceived the importance of this information, e.g. congestion more compared to male drivers. It is perhaps that they felt confident if they knew in advance regarding the congestion messages. They could be able to make better decision such divert to other route in order to avoid the congested route. However, one may argue this assumption. It is because past studies have revealed that female drivers are more vulnerable than male and in fact they also have poorer abilities n navigation (Streff & Wallace, 1993). Thus, it is predicted that female drivers may not be able to behave accordingly while on the road. Therefore, there would seem to be a good reason to believe that females requires greater reassuring information, as a result of their perception of poorer performance. However, one may also argue against this issue. Male drivers also would like to receive traffic information concerning congestion. This does not meant that male drivers were better performers than female. As a conclusion, the findings revealed that female drivers required the information on congestion more than male. Thus, the intelligent systems should be able to convey more information on congestion such as predictive information on the congested route, travel time or time spent on congested route etc.

In addition, there are also differences in age group. Group 2, e.g. middle-aged group would prefer to have information on trip planning than others such as younger and older drivers. This may imply that trip planning is important for middle age drivers. They need the information in order to plan their work to home trips. This information may help them in achieving their target, e.g. reaching home from work.

In general term, this survey revealed that the middle age group required information on trip planning more than the other counterpart. It is possible that the result is linked to their driving experience and part of their job, e.g. always going to unfamiliar destinations. In addition, the need of the trip planning information probably is related to the need of planning the commuting trips to home, It is because some of the motorists would prefer to try new route for pleasure (Dewan Masyarakat, 1992). However, one may question the significance of this information in assisting drivers, e.g. planning their trips. In fact, they already have experienced the regularity of commuting trip to their home. Indeed, they have knowledge regarding the route and time that they need to go to their home. Thus, the need for trip planning information may not be suitable unless they have to travel to an unfamiliar destination which require more information in order to arrive to their intended destination.

In conclusion, the above result should be treated with caution. Firstly, because of no other data that could support the claims. Secondly, other factors could evoke drivers' need for trip planning information. For example, to avoid congestion, they need to know the travel time if they were to take another route. However, this study did not investigate the underlying reason behind the local motorists' preferences toward the requirement of trip planning information. The implication for system designers is that they must be able to supply the information to the target end users and only given if requested by drivers. It is because not every driver would like to be told their journey if they already have good knowledge about it.

The findings also revealed some differences between male and female drivers regarding the information that they need when faced with congestion while en route to work from home. The result shows that female respondents need information on location of congestion compared to males. This may suggest the importance of knowing the location of congestion. This information may give them some knowledge to enable them to avoid congested route. In addition, female drivers also prefer to have more information on traffic state prediction. This may imply that females heavily needed the information in order to plan or deciding their action. This is because the information itself contained several indications regarding the traffic itself such as traffic flow on certain time and road. Thus, we could indicate that female drivers were more cautious than male drivers are. It is perhaps that they wanted more safety while commuting to work compared to their counter part. Some local studies found that female drivers are more careful while on the road than male drivers (Dewan Masyarakat, 1992). However, the need of these information by females does not mean that they were more cautious than male. It is perhaps that such requirement of information could help them to make accurate decisions. Nevertheless, the findings clearly reveal that system designers need to resolve these differences regarding information need among the motorists. One important feature is that the information on location of congestion and traffic state prediction were considered important as they could assist drivers decision making sand this should be installed in the systems.

The statistical analysis also shows the differences between male and female responses on the information that could help in deciding whether to divert to alternative route. The result shows that female drivers would prefer to have more information on differences in travel time between two routes compared to males. This shows that in deciding to divert to alternate route, female drivers need secondary assistance information, e.g. differences in travel times between two routes (i.e. the original route and alternate route) before they actually did it. This may suggest the importance of the information to female drivers in influencing their decisions.

Such gender differences may imply that saving time is important for female than male. In fact, the study also found that more females preferred to avoid congested route than male drivers. This demonstrated that female drivers more interested in minimizing wasted time that they would encounter. However, this statement may be inconclusive since there is no reported data regarding the differences between male and female drivers in local scenario. A further factor which may explain the preference of females for differences in travel time between the two routes is perhaps their limited knowledge regarding the other route or route network. Indeed, the survey did find that female drivers have limited knowledge regarding alternative route that they have known. In fact, they only knew one such alternate route that they could take to and from work. Thus, we could indicate that they might have less information regarding route network. Therefore, they may need some assurance information before deciding to divert to alternative route suggested by the information systems. This unfamiliar/limited knowledge on route network may hamper their decision-making abilities in terms of making accurate decision.

Nevertheless, the findings demonstrated the need for system designers to think about presenting some important information before users decided whether to divert to alternative route. This clearly shows that some drivers may need pre-information before making decision such as diverting to alternative route. The need to know travel time when taking the suggested route implied that some of the drivers may prefer to have some assistance in making decision. Thus, system designers need to develop some intelligent systems that is capable in presenting some accurate information for the use of its end users. Kantowitz et al., (1997) suggested that if the information given by the systems was not accurate, users may have lower confidence and the systems may not attract others to use it. The systems should have at least three types of information on it, e.g. static, dynamic and predictive which could be used by its end users (e.g. Ben Akiva et al., 1992).

One of the interesting findings in this study was the effect of driving experience on the requirement of traffic information. The study demonstrated that older drivers would prefer information on traffic condition than their counterpart, e.g. younger and middle age drivers when making unfamiliar trips. This may suggest the importance of traffic condition when travelling to unfamiliar destination. In addition, the route choice study also showed that older drivers rated less traffic criteria as important when travelling to unfamiliar destination. Thus, this may suggest that older drivers may use similar preferences in determining their information requirements and criteria to be used in route selection. Thus, it could also be suggested that traffic condition influence drivers' ability in reaching their destination. It is because traffic condition offers several messages such as traffic volume and other which drivers could use in their driving task. Nevertheless, the findings do not mean that other drivers such as younger drivers did not want this information. They perhaps just want to know rather than to use in every task of their driving compared to older drivers.

However, this result contradicted with the findings for inexperienced drivers. The result shows that middle age group needs information on traffic condition compared to other age group. This may refers that they need more information on traffic condition while making an unfamiliar trip. In theory, inexperienced drivers may need this kind of information more than experienced drivers may. However, the finding ssuggested that middle age groups need this information more and this could be due to them feeling it is important to have more information to assist them while en route to their destination. Thus, system designers should be able to distinguish the different need of drivers especially based upon their driving experience in order to present the traffic information. The interesting point for system designers to remember is that the systems should be able to identify the information that need to be given to the specific users and its trip purposes. It was noted that although the trip purposes are similar, e.g. unfamiliar trips, the need for information differ, especially for the users who actually required the information. Thus, system designers should be able to figure out this problem before presenting the information to the target users.

The statistical analysis reveals that inside the sample participated in the study there exist some differences regarding information requirements, e.g. female vs. male etc. Such as result suggest that this information should be used in developing the intelligent systems, For instance, some systems should be catering for only one gender, e.g. female than male (i.e. system specific rather than general systems alone). In addition, the systems also should cater for the all trips and users needs. Moreover, the systems should be able to give accurate and reliable type of information in order to attract more users to use it. However, the findings reported in this study are not conclusive. Thus, it should be treated with caution especially when generalizing it to the commuter population in Malaysia. Nevertheless, this is the first study of its kind in trying to answer several questions before developing the intelligent systems for the use of motorists in Kuala Lumpur, Malaysia. It is hope that the several interesting data found will allow system designers to carefully develope the systems.

7.7. Chapter Conclusion

This chapter discussed the results of the interview survey of information requirements and other issues such as navigational strategies and route choice criteria. The findings clearly show that there exist various types of local drivers' navigational strategies. The route planning and wayfinding result shows that most of the respondents would prefer to use maps, i.e. road and city map in order to planning their trips and findings their way in unfamiliar environments. Other strategies that drivers would like to use were stop and ask someone for direction, went without planning and others. These strategies will assist drivers in planning and finding their way while driving. However, these methods were also affected by the accurateness of information that drivers received. Unfortunately, the study did not examine the effectiveness of these strategies in assisting drivers in achieving their goal, i.e. planning and findings their way. The finding highlight the local travelers strategies when planning and findings the way in unfamiliar destination.

Drivers route choice for several different types of journey also varied. The study showed that drivers would employ various kinds of criteria in selecting a route to their destination. Nevertheless, it is unknown whether these criteria could affect drivers' real life performance when they employ these criteria to choose a route to a particular destination. This study shows the difficulty of arriving at universal agreement regarding drivers route choice criteria. Indeed, perhaps, there are other factors that could influence drivers' route choice criteria, e.g. travel time uncertainty. The results on information requirements show that respondents agreed on the ranking of importance of the information that they required. The findings revealed that most of the information needed is related to trips and situations that they faced, e.g. congestion. Trip purposes, e.g. commuting trips influence drivers information needs. For example, alternative route and route guidance will certainly help drivers think about the possibilities of the best optimum route to take in order to avoid congestion. As mentioned earlier, the trip purposes would certainly influence the requirements of information for different type of journey.

Indeed, the timing to present the information also varied, as it is related to the nature of the trips. Some of the information was required before driving in order to make better decision regarding the journey. For instance, information on difference in travel time between two routes, i.e. original and alternative route as drivers would like to know this information before they decide to divert to alternative route. Therefore, the timing of information to be presented to the drivers could influence their decision of what to do next, i.e. divert to alternate route or continue to use on their regular route. Most of the respondents would like to receive the information that they required from commercial radio. In fact, most of the motorists around the world have acquired some form of traffic information presented to them by commercial radio. Indeed, some of the respondents have experienced receiving traffic information from commercial radio compared to other medium. In addition, some of the systems, i.e. VMS, RDS-TMC is new to the commuters' population in Malaysia. Therefore, some drivers did not know the capabilities of these new systems which aim to assist drivers while driving.

Indeed, there exist some differences between gender and age of the respondents regarding the information that they required for certain types of trips. The results suggest that the notion of drivers population is not homogeneous is in fact supported by the data obtained in this study. In addition, some of the findings were new especially to the knowledge of the responsible agencies regarding driver's information requirements. However, the study provides a cause for other studies to investigate further regarding local driver's information requirements.

Chapter 8: Presentation of Traffic Messages

8.1. Chapter Summary

This chapter describes the experiment that was conducted with the aim to investigate several behavioural issues related to the presentation of traffic messages about congestion. These behavioural issues comprised driver responses toward the traffic messages, the importance of traffic message contents that influence motorists' responses and preferences of traffic messages. The chapter ends with the discussion of the results.

8.2. Introduction

The preliminary and main studies have classified a variety of types of information that drivers require for several trip purposes. However, there is no guarantee that the traffic information that a driver requires is appropriate in terms of in what modality should it be presented. It is because the effectiveness of the traffic information required is also related with the issue of in which medium should the information be presented. Indeed, based on the preliminary and main studies results, commercial radio was the preferred mode in presenting traffic information. In fact, there was significant number of motorists' (in reality) experience of being informed by the commercial radio. Thus, the experiments were conducted to explore several behavioural issues when drivers were given several traffic messages concerning congestion by using verbal mode of information presentation.

The study reported in this chapter addresses the issues of driver response, content of and the preference of traffic messages. Traffic messages were conveyed by using verbal mode compared to other medium such as symbols, map etc. It is argued that the messages that drivers received may not be represent the actual traffic messages given by commercial radio. However, the study conducted in this chapter serve as a precursor to future study in examining driver's response toward traffic message. In addition, non-availability of certain systems, e.g. simulator, road-track or even visual information systems (i.e. combination maps or symbols) had prevented the use of sophisticated systems in measuring drivers' responses.

Past studies had shown the advantage of presenting verbal type of information compared to visual information. For example, the study by Streeter et al. (1985) that aimed to compare the effectiveness of various information displays. They compared four different types of navigation: verbal directions, paper based customised route map, verbal instructions combined with a customised route map, and conventional paper maps (control group). The result shows that the shortest distance and fastest completion times were found in the participant with verbal instruction condition. They also found that most navigational errors were committed in the map alone condition and subject which received only verbal instructions committed fewest errors. Subjects prefer verbal instructions compared to other instructions. In conclusion, they suggested that the information (e.g. route guidance) systems should be voice oriented because of its superiority over maps.

In addition, Van Winsum (1987) study clearly showed the superiority of verbal over maps. He investigated simple verbal left or right turn instructions, which were compared to a map display of route information. The effectiveness of the two-route guidance display was evaluated based upon navigational errors made during the experiment. Van Winsum found that the errors in the map condition were mainly attributed to the subjects' difficulties in keeping track of their position on the map while there was no errors committed when verbal instructions were given.

Labiale (1989) aimed to compare the performance of three different methods of displaying in-vehicle route guidance information: electronic maps, maps with auditory information, and map with written information. He found that drivers prefer map with verbal directions. He concluded that with respect to glance duration, map presented with verbal directions was the safest way to present the route guidance information. In addition, Pauzie and Anadon (1993) conducted a study comparing wayfinding performance with guidance from directional arrows combined with preparatory beeps or verbal instructions. Subjects in their study indicate that verbal information is sufficient. However, they concluded that a combined verbal-visual display was optimal because vehicle noise might be problematic for speech only guidance.

Huchingson et al (1979) meanwhile tried to examine the meaning of Major Accident and Minor Accident that was presented to drivers. The rationale of this study was that they reckon if these expressions could be used instead of the exact minutes of delay, the operating agency would be relieved of the problem of continually updating the message for accuracy and the associated problem of message credibility. Drivers in the major group were asked to indicate the minimum number of minutes delay implied (x minutes or more), while drivers in the minor group were indicated to give the maximum delay implied (x minutes or less). Huchingson et al., found that minor implied 12 minutes or less to the median driver, whereas major implied about 22 minutes or more. However, they did not conclude the exact minute of delay based upon the response of both groups. Nevertheless, they stressed the importance of different meaning conveyed by the different group regarding types of expressions of accidents.

Dudek et al. (1978) tried to examine the word delay. In reality, delay means many different things to drivers, but the most popular meanings were that freeway travel will be so-many minutes longer than usual, or that one will arrive so-many minutes later than usual. However, it does not necessarily mean traffic was stopped that long or that it would take that long to remove an obstruction. They concluded that temporal information in terms of minute delay is an effective method of traffic control when the objective is to induce diversion of various percentages of the drivers.

Huchingson et al. (1984) also conducted another study to investigate the meaning of Major Delay and Minor Delay rather than the word accident. In their study, they also clarified the meaning of delay by asking the respondents about how long would they expected to be delayed in comparison with their normal travel time. They found that Major Delay also implied 22.7 minutes or more delay. However, the study also failed to find any difference between drivers in terms of their interpretations of Major and Minor Delay.

Taken as a whole, the above studies showed different findings regarding different issues raised in this chapter. For example, previous works recommend the use of verbal mode of presenting traffic messages than other types of modes, e.g. maps or visual. In addition, different connotation or expression concerning words or terms used in commercial radio such as delay or accident were also investigated. The findings clearly showed different results depending upon the context in which the words or terms were being examined. However, for this study, traffic messages presented by commercial radio were used to investigate drivers' response. The reason for employing verbal mode of presenting information because drivers in Kuala Lumpur had only experienced being given information by commercial radio station. Furthermore, other modes of information presentation cannot be investigated due to non-availability of such equipment. The study reported in this chapter investigated the behaviour of motorists when presented with traffic messages on congestion. The next section describes the aims of the experimental work.

8.3. Aims of the Experimental Study

The primary aim of this experiment was to explore behavioural issues relating to the presenting of traffic message concerning congestion in several aspects:

- drivers' response and reason of their response regarding traffic message on congestion
- content of important elements / attributes in the traffic information that contribute to the drivers decision regarding their response and reason of their response
- drivers' preferences on traffic information regarding congestion, which could use in developments of traffic messages on congestion

In this experiment, six types of traffic messages (6 condition) were given to the respondents. By presenting six types of traffic messages, it was hope that the experiments could highlight new information on drivers' response and reason of their action regarding the traffic messages that has been presented. In addition, the study could also provide new ideas on the important aspects or criteria that should be included in the traffic messages which is useful to drivers.

8.4. Method

8.4.1. Design of Experiments

An important issue regarding the choice of experimental design was the decision to choose the design of the experiments. By reviewing the past literature regarding the presentation of traffic message to drivers, two types of experimental designs emerged. One refers to factorial (i.e. between subjects) in which each subject would experience only one condition. The other is repeated design (i.e. within subjects) in which each subject would undertake all six conditions. Indeed, based on literature, a repeated design (i.e. within-subjects) was employed The reasons of selecting within subject designs varied. For example, it required a small number of subjects. In fact, based upon Dudek et al (1982), the number of their subjects was 20. In addition, Graham & Mitchell (1997) also employed small number of subjects when they employed a repeated design experiment.

Furthermore, the need to examine subjects' responses when they were given traffic messages certainly proved the advantages of this design. Subjects were asked regarding messages on congestion. Thus, it is appropriate to investigate their behavioural response toward all the information rather than only one message. This procedure was employed in order to collect more relevant data concerning subject response. In addition, non-availability of important equipment such as simulator prevents the use of advanced experimental designs such as factorial designs. Past studies showed that many investigators used factorial designs when they employed variety of types of equipment in measuring subjects' responses such as road trial, simulators.

A repeated design was chosen because it enables subjects to be tested simultaneously according to a different or randomly assigned schedule. This randomly assigned schedule of traffic messages were employed to reduce biases (Rosnow, 1968; See Appendix 6).
In this study six types of traffic messages were presented to participants (i.e. drivers).
Six traffic messages conditions were presented to respondents were:

- Congestion Ahead refers to warning on congestion
- Congestion Ahead - Delay 1 hours comprised message on warning and time delay caused by congestion
- Congestion Ahead - 3 km covers message on warning and length of congestion
- Congestion Ahead - Follow Diversion Signs message on warning and suggestion to use alternate route

- Congestion Ahead - Follow Diversion Signs - Delay 1 hour message on warning and suggestion to use alternate route with time delay when using the suggested route
- Congestion Ahead - Follow Diversion Signs - 3 km message on warning, suggestion to use alternate route and length of that alternate route.3

The rationale of employing these traffic messages in the experiments was to investigate drivers' reactions when they were presented with several different kind of messages that have variety of element in it. This is useful for system designers to know what kind of reaction given by the target audience and traffic preference for the use of future traffic message designed by the system designers. Apart from that, the rationale of using several different types of traffic messages in the experiment was to investigate whether the elements given in this study is appropriate to be use in the future traffic messages.

In addition, system designers could have some insights regarding the action and elements to be included in the traffic messages on congestion. For example, past studies revealed that different responses were given by different types of drivers concerning the same traffic messages (e.g. Huchingson study). Thus, it was the intention of the researcher to use different types of traffic messages on congestion, in order to gather more data regarding drivers' decisions and reasons for their decisions.

Various types of traffic messages on congestion were used in the experiments which comprised elements such as the suggestion to use alternative route. Based upon Dudek study, they used this element in order to induce drivers to use other route. The researcher's intention was to investigate whether drivers would follow this kind of advice or not. Thus, it is vital for system designers to know if the potential users did not regard the advice as important.

The rationale of the messages used in this study was that many local drivers found that local commercial radio often do not update the information on congestion and also many of the messages given were general in nature. Thus, the researcher's intention was to investigate whether the use of different types of element and variety types of messages could be used in local scenario. Although, some might say that the experiment conducted in this study did not represent the actual scene but the experiment was the first of its kind in Malaysia. Therefore, the information gathered in the study was useful for guidelines and as a comparison with future study and past literature. Indeed, the findings revealed that some of the findings were similar with the past literature such as Dudek et al and Huchingson et al study.

8.4.2. Participants

The subjects were picked by using a purposive sampling based on the same criteria used in the main survey, e.g. certain ages, ethnic, gender, lives in Kuala Lumpur and its surrounding areas and others. All of the subjects held a full Malaysian driving licence and commute to and from work daily by using car as a means of transportation. Sampling frame of selecting subjects was based on Universiti Kebangsaan Malaysia list of staff. In addition, residents from Bandar Baru Bangi have been asked to participate in the experiment. All of the respondents were paid. Twenty-one subjects took part in the first experiment; 13 of them were male and 8 female. Participant's age ranged from 24 to 47. The first experiment was regarding traffic messages presented for home to work commuting trips. Whereas, in the second experiment, 20 respondents participated; 10 of them were male and 10 were female. Their age ranged from 25 to 45 years old. The second experiment involved the presentation of traffic messages for work to home commuting trips.

8.4.3. Instruments

The experiments were conducted in the individual laboratories at Department of Psychology, Universiti Kebangsaan Malaysia. The individual laboratory was picked because it separates respondents from each other. The laboratory was redesigned in order to make sure that the experiment could be done. The new laboratory has 12 speakers (1 left and 1 right speakers in each of the cubicles), 6 microphones and 6 earphones (if the respondents do not want to use speakers). There was one main room which located the main sources of the recorded traffic messages. In the room, there was a sound system that includes a tape recorder which has been used to convey the messages to the respondents in six cubicles. Traffic messages has been recorded before the experiment begins.

The respondents were asked to sit in the laboratory and listened to the six pre-recorded traffic messages regarding congestion. They were required to answer a questionnaire (See Appendix 7) that was provided. The questionnaire contained several questions that asked respondents regarding the traffic messages they have heard. Question asked in the questionnaire were drivers' response and reason of their response, important aspects that help them to make decision and traffic messages preferences.

8.4.4. Procedure

Before the actual experiments begin, subjects were given a series of informal talk with the aims to familiarise participants with the task (e.g. listening to traffic messages and answer the questionnaire). The participants also took part in a pilot study in order to make sure that the experiment schedule went according to plan. The aims of the pilot study was to make sure that subjects know their task, the schedule of the experiment was appropriate and the questionnaire used was capable in eliciting relevant information given by the subjects. The subjects were instructed to sit in the individual laboratory. Inside their own cubicles, they were given another instruction, e.g. asking them to imagine that they were on their way to work (first experiment) and they were on their way to home (second experiment). In between journey, they were presented with several kind of traffic messages regarding congestion. The subjects were also instructed to note down their responses in the questionnaire/checklist provide. At the end of the experiments, respondents were asked if they have any queries regarding the experiments. Research assistants then collected the checklist and assign it to two sections, i.e., first study which deal with commuting trips (home to work) and second study which involving commuting trips (work to home). The experiment took 45 minutes to 1 hour to finish.

8.4.5. Data analysis

Data collected in the experiments were based upon the respondents' responses on the checklist/questionnaire. The checklist/questionnaire used in the experiments contain mainly open-ended questions. The data collected were mainly drivers' own subjective response according to the need of the study which aimed at investigating drivers' responses regarding several kinds of traffic messages.

The information gathered from both experiments (i.e. from home to work and work to home) were manually entered into a single computer file using a spreadsheet program (i.e. Excel Worksheet). The open-ended questions were coded as each different answer was encountered. There was no information lost and these codes could be categorised into more general response categories later if required. Data were screened for encoding error and compiled using SPSS (Statistical Package for the Social Sciences). Result of the experiments will be described in the next section.

8.5. Results

The result of the experiments were divided into two sections, first section involves the experiment regarding the presentation of traffic message from home to work trips and the second section deal with the result of the second experiment concerning the presentation of traffic messages from work to home trips. The result of the experiments are described as follows:

8.5.1. Home to work trips

Drivers' response and reason of their response

Table 8.1 explained drivers' response and the reason of their response when they were given several kind of messages on congestion. There were two main responses, e.g. to stay on the same route or divert to another route. In addition, the reasons for the above responses varied. For example, drivers would divert to another route because they were afraid to be late at work. However, one could argue the significant of this single value of messages. It does not contain much detail such as informing how long the delay is. Thus, it may suggest that drivers would use their past experience to make their decision. Subjects also were given messages that contained time delay caused by congestion. They would also divert to another route because they need to get to work on time. This may suggest that drivers were influenced by time delay factor presented in the traffic messages. Furthermore, some drivers would divert to an alternative route because they knew of other routes to take. This indicated that some drivers might have good a knowledge regarding alternative route that they could take to their destination, e.g. work.

As mentioned earlier, some drivers would remained where they are even though they knew of the delay caused by the congestion. In addition, their reasons of staying on the same route also varied. For example, although they know the time delay was caused by the congestion, drivers believed that the delay would be for only 1 hour. This assumption was stemmed from their past experiences when trapped in a traffic congestion. Other responses mentioned by the respondents were they would change the mode of transport out of fear of being late to work. Indeed, time factor plays an important role in influencing drivers' decisions. In addition, some of the drivers even suggested stopping at resting points such as restaurants etc - believing that the delay would not last more than for 1 hour. This may suggest that some drivers would prefer to stay at stopping point rather than to be stuck in congestion

Table 8.1. Response and reason of response (home - work)

Traffic messages	Response	Reason of response
Congestion Ahead	Divert to other route	Late to work (33.3%) Knew other route (28.6%)
	Stay - the same route	Jam will be ease (9.5%) Experiences (28.6%)
Congestion Ahead - Delay 1 hour	Divert to other route	Work on time 38.1%)
	Stay - the same route	1 hour delay (23.8%) < 1 hour delay (9.5%)
	Change mode of transport	Late to work (28.6%)
Congestion Ahead - 3 km	Divert to other route	Not involve in jams (33.3%) Try other route (14.3%)
	Stay - the same route	No alternative (33.8%)
	Change mode of transport	Use other mode (28.6%)
Congestion Ahead- Follow Diversion Sign-	Stay - the same route	Non congested route (52.4%)
	Divert to other route	Don't trust the sign (33.8%) Find other route (14.8%)
Congestion Ahead - Follow Diversion Sign- Delay 1 hour	Divert to other route	Knew other route (47.1%)
	Stay - the same route	Delay only 1 hour (23.8%) Police will help (10%)
	Stay at stopping point	Delay > 1 hour (19.1%)
Congestion Ahead - Follow Diversion Sign- 3 km	Divert to other route	Knew other route (51.9%)
	Stay - the same route	Police will help (33.8%)
	Stay at stopping point	Not to waste time (14.3%)

Important content of traffic messages

Table 8.2 presents the results regarding the important contents or elements on traffic messages on congestion, which may influence drivers' decisions, e.g. their responses.

Table 8.2. Important elements of traffic messages (home-work)

Category of traffic messages	Description	Important elements/contents
Congestion ahead	Warning about congestion	Think of other route (52.5%) Advanced warning (19%) Early - go to work (9.5%)
Congestion Ahead - Delay 1 hour	Warning about congestion And time delay caused by Congestion	Time delay (62%) Think of other route (19%) Traffic police will help (19%)
Congestion Ahead - 3 km	Warning about congestion And length of congestion	Distance of congested route (61%) Think of other route (30%) Causes of congestion (9%)
Congestion Ahead - Follow Diversion Sign	Warning about congestion and suggestion to use the recommended route	Follow diversion sign (90.5%)
Congestion Ahead - Follow Diversion Sign - Delay 1 hour	Warning about congestion And suggestion to use the recommended route and time delay when using the route	The same messages (100%)
Congestion Ahead - Follow Diversion Sign- 3 km	Warning about congestion and suggestion to use the recommended route and length of the route	Length of the diversion route (100%)

Traffic messages presented to the drivers contained several important elements, which were helpful. For example, drivers indicate that messages such as "congestion ahead" or "congestion ahead - delay 1 hour" were important in helping them to think about the other possible solution, e.g. alternative route. Elements such as time delay and length of congestion could also influence drivers' decisions. This may suggest the need to include both elements/content, e.g. time delay and length of congestion in designing the actual traffic messages. Furthermore, the suggested route (e.g. follow diversion sign) recommended by the systems was also regarded as important by the respondents.

The timing of the messages were also considered important. Respondents wanted some of the messages to be presented early, e.g., "congestion ahead". This may influence their decisions, e.g. depart early to their destination, e.g. work. This may suggest that some drivers stressed the need of presenting messages as early as possible perhaps before their departure to their destinations. In addition, some of the drivers also stressed the need for a secondary assistance from traffic police. Traffic messages on congestion may evoke the needs for assistance from traffic police. Furthermore, some of the drivers mentioned the priority of having the knowledge of other details such as the cause of the congestion. This may suggest that some of the drivers stressed the need of more information on the congestion, e.g. causes of congestion that should be given to them.

Preferable traffic messages on congestion

Table 8.3 shows the result of drivers' preferences on traffic messages concerning congestion. Drivers' preferences vary. The result shows that some of the drivers would like to have the information presented to them early perhaps before they depart to their destination, e.g. work. In fact, all the information was needed early. This could help drivers in making effective decisions. This may suggest that the importance of presenting information on congestion, e.g. time delay caused by congestion, early before drivers start their journey to the destination, e.g. work. In addition, the drivers also prefer to have more information or solution to the congestion problem. For instance, when presenting "congestion ahead-delay 1 hour", some drivers stressed the need to have information that offers an alternative route to take in order to avoid the said congestion. This may suggest that drivers do not only want information on congestion but also some solution to the problem. Thus, system designers should develop a message that could also suggest a solution to the congestion problem.

The result also shows that drivers also prefer to have more information on congestion or delay. For instance, drivers also would like to know several facts regarding the congestion such as causes, condition, how long (e.g. time delay) of the congestion. Thus, the messages may play a significant role in influencing drivers' decisions when they are actually involve in a congestion while commuting to work. In addition, respondents also prefer to have information on travel time (e.g. expected travel time) when they choose to use the suggested route recommended by the information systems. This may suggest the importance of travel time to the drivers especially when commuting to work because they need to be on time at work in order to minimise late penalty arrival (e.g. Noland, 1997). Nevertheless, the study found that drivers require more information when they were presented with different types of traffic messages on congestion.

Table 8.3. Preferable traffic information on congestion (Home to work)

Category of traffic messages	**Description**	**Important elements/contents**
Congestion ahead	Warning about congestion	Presented early (48%) Offer solution, eg. alternative route (29%) Congestion facts, ie. How long (23%)
Congestion Ahead - Delay 1 hour	Warning about congestion And time delay caused by Congestion	Offer solution, eg. alternative route (42.8%) Congestion facts, eg. location (28.6%) Presented early (28.6%)
Congestion Ahead - 3 km	Warning about congestion And length of congestion	Offer solution, eg. alternative route (47.6%) Congestion facts, eg.causes (23.3%) Presented early (29.1%)
Congestion Ahead - Follow Diversion Sign	Warning about congestion and suggestion to use the recommended route	Time when use the route (57.2%) Offer solution, eg. other route (23.7%) Presented early (19%)
Congestion Ahead - Follow Diversion Sign - Delay 1 hour	Warning about congestion And suggestion to use the recommended route and time delay when using the route	Presented early (61%) Delay facts, eg. condition or causes (39%)
Congestion Ahead - Follow Diversion Sign- 3 km	Warning about congestion and suggestion to use the recommended route and length of the route	Above messages plus travel time using the route (70%) Presented early (30%)

8.5.2. Work to home trips

Response and reason of drivers response

Table 8.4 shows the results of drivers' responses and reasons of their responses when given traffic messages on congestion in the second experiment, e.g. from work to home. Similar as in the first experiment, two main responses were to stay on the same route or divert to another route. In addition, the reason for drivers' responses also varied. For instance, when drivers were given the message "congestion ahead-delay 1 hour", drivers said that they would stay on the same route even though they knew the time delay caused by congestion. The reason drivers would stay on the same route was because they believed the delay was only for 1 hour. This may suggest that drivers may used their past experience when they are involved with a congestion to determine their decision.

When drivers were given traffic messages on congestion, they would divert to other route. For example, when given information, e.g. "congestion ahead- 3 km", the drivers said they would divert to another route in order to avoid congestion. This may suggest that drivers have good knowledge on the route network of their commuting trips.

Other responses indicated by drivers were they would stay at a stopping point, e.g. restaurants, gas station etc or work overtime. For instance, drivers indicate they would stay at a stopping point because it does not matter if they arrive late at home and they do not want to get involve in congestion. In addition, drivers also indicated they would work overtime because they feel it is worth their time rather than to be involved in congestion. They may gain financial benefits rather than being trapped in the congestion.

Table 8.4. Response and reason of response (work-home)

Traffic messages	Response	Reason of response
Congestion Ahead	Divert to other route	On time at home (20%) Knew other route (30%)
	Stay - the same route	Jam will be ease (40%)
	Stay at stopping point	No matter the delay (10%)
Congestion Ahead - Delay 1 hour	Divert to other route	Pick up family (20%) Knew other route (20%) Don't want to involve (15%)
	Stay - the same route	Only 1 hour delay (35%)
	Stay at stopping point	Don't want to involve (19%)
Congestion Ahead - 3 km	Stay - the same route	Experience (30%) Only 3 km jam (15%)
	Divert to other route	Knew other route (35%)
	Work overtime	It's worth (20%)
Congestion Ahead- Follow Diversion Sign-	Divert to other route	Find other route (45%)
	Stay - the same route	Route to avoid jams (20%) Police help (15%)
	Work overtime	It's worth (20%)
Congestion Ahead - Follow Diversion Sign- Delay 1 hour	Stay - the same route	Other route also jams (30%) 1 hour delay only (10%)
	Divert to other route	Delay > 1 hour (20%) Often use other route (15%)
	Work overtime	It's worth (25%)
Congestion Ahead - Follow Diversion Sign- 3 km	Stay - the same route	Only 3 km (35%)
	Work overtime	It's worth (35%)
	Divert to other route	Not to waste time (20%) Knew other route (10%)

Important content of traffic messages

Table 8.5 shows the important elements or attributes on traffic messages on congestion based upon respondents' opinions. Similar to the first experiment, different kinds of traffic information on congestion had several important elements that could influence drivers' decisions.

In addition, drivers' responses regarding the important elements on traffic messages on congestion varied possibly due to their experience and other factors. For instance, "congestion ahead-delay 1 hour" or "congestion ahead-3 km" have important elements that contributed to drivers' decisions. Time delay caused by congestion and length of congested route were perceived as important. This may suggest that several criteria such as time or distance may play a significant role in influencing drivers' decisions. Thus, the element/criteria such as time delay caused by congestion or length/distance of congestion should be included in messages on congestion. Messages such as "follow diversion sign", i.e. suggestion to use recommended route, was also considered as important by the drivers. This message may influence drivers' decisions whether to use the suggested route or for example, divert to other route. Thus, systems designers also need to include some assistance or reassurance messages such as providing other alternative route just in case the user tend not to follow the system's suggestion.

Table 8.5. Important elements of traffic messages (Work - home)

Category of traffic messages	Description	Important elements/contents
Congestion ahead	Warning about congestion	The same messages (75%) Nothing important (25%)
Congestion Ahead - Delay 1 hour	Warning about congestion And time delay caused by Congestion	Time delay (90%) Nothing important (10%)
Congestion Ahead - 3 km	Warning about congestion And length of congestion	Distance of congested route (100%)
Congestion Ahead - Follow Diversion Sign	Warning about congestion and suggestion to use the recommended route	Follow diversion sign (80%) Nothing important (20%)
Congestion Ahead - Follow Diversion Sign - Delay 1 hour	Warning about congestion And suggestion to use the recommended route and time delay when using the route	The same messages (100%)
Congestion Ahead - Follow Diversion Sign- 3 km	Warning about congestion and suggestion to use the recommended route and length of the route	Length of the diversion route (100%)

Preferable traffic messages on congestion

Table 8.6 presents the results of drivers' preference on the different kinds of traffic messages on congestion. Similar to the first experiment, the respondents also prefer to have more information. The drivers would like to have information which could offer them a solution to the congestion problem such as providing an alternative route. For instance, when drivers were given traffic messages on congestion such as "congestion ahead-delay 1 hour" or "congestion ahead-3 km", they would prefer to have some sort of solution to the problem e.g. by providing an alternative route, the respondents may be able to avoid the congested route.

The drivers also stressed the need to present several kinds of traffic messages as early as possible perhaps before they depart to their destinations. For instance, when drivers were given information such as "congestion ahead-3 km" or "congestion ahead-follow diversion sign-3 km", they clearly stated the need to have these information prior to the departure to their destination, e.g. home. Indeed, these information could serve as an advance warning to drivers regarding their decision, for example, whether to stay on the same route or working overtime (e.g. delay departure time).

Apart from the need for early traffic messages on congestion and solution to the congestion problem, the drivers also prefer to have more information or facts on congestion or delay that they will anticipated. For instance, traffic messages such as "congestion ahead" or "congestion ahead-follow diversion sign-delay 1 hour", the respondents also stressed the need to have more details on the congestion such as causes of the congestion or delay and location of the congestion. This may suggest the need to have more information or detail on congestion which drivers think useful in influencing their decision.

Finally, respondents also preferred to have more information on travel time. When given several kind of traffic messages such as "congestion ahead-follow diversion sign", "congestion ahead-follow diversion sign-delay 1 hour" or "congestion ahead-follow diversion sign-3 km", they would prefer to have information on travel time which covers two aspects such as expected time when using suggested route and expected time to arrive at their destination (e.g. home). This may suggest the need to have more information on travel time, which needed to be included when designing a future traffic messages on congestion.

Table 8.6. Preferable traffic messages on congestion (Work - home)

Category of traffic messages	Description	Important elements/contents
Congestion ahead	Warning about congestion	Offer solution, eg. alternative route (60%) Congestion facts, ie. How long (40%)
Congestion Ahead - Delay 1 hour	Warning about congestion And time delay caused by Congestion	Offer solution, eg. alternative route (70%) Presented early (30%)
Congestion Ahead - 3 km	Warning about congestion And length of congestion	Offer solution, eg. alternative route (40%) Expected time-arrive at destination (35%) Presented early (25%)
Congestion Ahead - Follow Diversion Sign	Warning about congestion and suggestion to use the recommended route	Expected time when use the route (45%) Length of the route (35%) Presented early (20%)
Congestion Ahead - Follow Diversion Sign - Delay 1 hour	Warning about congestion And suggestion to use the recommended route and time delay when using the route	Expected time to arrive at destination (45%) Delay facts, eg. Condition or causes (40%)
Congestion Ahead - Follow Diversion Sign- 3 km	Warning about congestion and suggestion to use the recommended route and length of the route	Above messages plus travel time using the route (65%) Presented early (35%)

8.6. Summary of the results

The present works clearly shows some interesting insights, which could be used in the preliminary stage of designing a suitable traffic messages to be presented to the target audience, e.g. motorists. For example:

- Different types of traffic information may activate different kinds of responses by drivers. This may imply that drivers' behaviours may be influenced by the messages that they received. In both studies, most of the drivers' responses can be categorised into two main responses: (a) divert to other route, (b) stay on the same route. Other responses were (c) change mode of transport, (d) stay at stopping point and (e) work overtime.

- Reason of their responses also varied. Thus, it was suggested that drivers' responses were related to the nature of the trips, e.g. whether they were travelling to work or home. For example, for home to work trips, the respondents would divert to other route because they were afraid to be late for work, e.g. time constraints. Whereas, for work to home trips, some of the respondents would stay at stopping point because it was not worth to be trapped in a congestion, i.e. wasting time.

- Traffic messages on congestion presented contained different content/element which respondents perceived as important. For example, time delay caused by congestion could influence drivers' decisions. Thus, it is suggested that traffic messages should comprised several important content / element such as time delay and length of congestion.

- In addition, the drivers also prefer to have more information on traffic messages. For example, the need to include several facts on congestion itself such as location, reason and how long, e.g. time factor. Furthermore, the messages should be presented early, which indicate the need to have that information to serve as an advanced warning. In addition, some of the respondents clearly preferred the same messages.

8.7. Methodology Issues

There are several points upon which the study described in this chapter can be criticised:

- There is no indication as to the reliability in the respondents' responses. It is because the responses were based on their opinion in hypothetical scenario which may not represent the actual driving situations. Indeed, their responses were based on their opinion/memories that subjected to problems such as error and bias.

- The selection of participants were based on a purposive sampling that did not guarantee equal chances of subjects to be participated in the study. Thus, the findings would not represent any meaningful population (e.g. Babbie, 1992). Consequently, the generalisation of the findings to the overall commuter population in Malaysia should be treated with caution.

- A majority of the respondents took part in the experiment came from a local university. Thus, they may have knowledge regarding the issue. Hence, they may have response favourably in the experiments. Indeed, some of the responses were confidently stated, e.g. finding the other route. This overconfidence may bring another problem, e.g. involved in an accident or the possibility of getting lost (e.g. Engels & Dellen, 1989).

- The experiment covers limited number of traffic messages or element/content of the messages on congestion. It is thought that other types of elements may produced different responses. It is interesting to investigate behavioural response if a variety of elements/contents were used, e.g. 'delay 10 mins' or 'delay 30 mins'.

Although, the experiment has several drawbacks which could confounded the findings, it also have some advantages which could enhance the reliability of the information gathered such as:

- The procedure used in this study served well in obtaining data regarding drivers' decisions and reasons of their actions when presented with several traffic messages on congestion.

- In fact, some of the responses given also reflected the true nature of the real-life situation as evidenced in the past studies such as Dudek et al, Huchingson et al and Emmerink et al. This reflected that the experiment has some positive points which could enhanced the reliability of the data obtained in the study.

- The experiment has followed accurately the procedure as suggested by past researcher (e.g. Rosnow) in order to avoid mistake or external factors, to capture the relevant and vital data to serve the aims of the study. The vital and relevant information/data have been obtained and which reflected the behaviour of the local drivers which were somewhat similar to those obtained in past studies that used more advanced technique or objective measure such as simulations or field experiment at road track test.

- Even though, the messages given to the drivers were only subjective in nature and did not represent the true nature of traffic messages on congestion, it has given the researcher some interesting insights about the important element/points that need to be included before deciding to design future traffic messages on congestion.

- The experiment was the first in Malaysia that investigated the reactions of local drivers when faced with different kinds of traffic messages. The experiments has vital information for other researchers to ponder upon and used them to compare with other studies, foreign or local.

Although, the experiments were subjective in nature but it had some interesting points that need to be kept in mind by system designers. Thus, there is a need to conduct more objective type of research regarding behavioural response when presenting different type of traffic message to drivers.

8.8. Discussion of the findings

Based on the overall results, there are several points in which the study has highlighted some interesting findings regarding local drivers behavioural responses.

What kinds of decision taken by drivers?

Observation of the drivers' responses when given different types of traffic messages prompted different types of responses. Indeed, the responses could be categorised into two main responses:

- divert to other route
- stay on the same route

This implies that drivers may be influenced by the messages given to them. In other words, drivers might response to the message that they received from commercial radio. Indeed, Khattak et al (1993) have shown that drivers will likely divert to an alternate route based on the information they received from the secondary medium, e.g. commercial radio than based upon their own observation. In addition, Dudek et al (1971) also demonstrated that there were some hard core drivers who would stay on the same route even though they knew the delay on that route. Thus, the findings are in accordance with the above previous works.

Nevertheless, there are other factors that could influence drivers decisions. Thus, reason for drivers' decisions varied. In fact, it may relate to the nature of the trips that they were making. For example, respondents would divert to other route in order to avoid being late to work. Indeed, previous works also confirmed this assumption. Caplice et al (1992) revealed that congestion was the main motivator for drivers to change route. In addition, Noland (1997) also suggested that some drivers may even change their departure time (e.g. go to work early) just to avoid tardiness (i.e. no lateness policy applies in their workplaces).

There are also other responses which may represent local driver's own behaviours. Some of the drivers would change mode of transport, if the messages were conveyed to them early. This may suggest that the messages could influence drivers' decisions. Indeed, driver decision to change mode of transport could be based on several factors such as they believed they could save more time if they were to take taxis, buses of the light rail transit. Their beliefs may comprised knowledge that the alternative transportation may save time and belief/knowledge concerning the differences in variability of travel times (e.g. Van Vugt et al., 1996). In addition, the reliability of messages that were presented to the drivers may also influenced drivers' decisions. Kantowitz et al (1997) has shown that in order for information systems to be able to attract potential users, it should be able to present accurate and reliable messages. Furthermore, the systems should have the capability to convey three types of messages, e.g. static, temporal and predictive, which have different capabilities and information.

The other response indicated by the respondents was to stay at stopping point and working overtime. These responses could be classified as non-involvement with congestion. For example, some of the respondents who believed that by staying at stopping point, e.g. restaurant along the main highway, they could avoid traffic jam especially during rush hour. Thus, this belief may well be related to their own experience of being involved in congestion. Similar to the above cases, respondents also mentioned that they would work overtime (a representation of local drivers' actual behaviour). They would work overtime in order to avoid congestion that would lasted 1-2 hour after 5 p.m.

The experiment seemed to indicate that the respondents were not bothered about the time factor, e.g. whether they are late for work or home. However, there may be other factors that can affect drivers' decisions. For example, the nature of the trips may have an influence on drivers' responses and reasons for their responses. Unfortunately, this study did not investigate these other factors.

What is the important contents/elements of traffic messages that could influence drivers' decisions?

It was apparent from the results of the experiment that respondents perceived traffic messages given to them contained several important content/elements which could influence their decisions/responses. Traffic messages comprised six different messages with different content/elements that was necessary to be given to motorists. It is because messages given to the local drivers (in reality by variety of commercial radio stations) were in fact general in nature. Thus, it was the intention of the investigator to examine local drivers opinion/perception regarding important elements that need to be included in future traffic messages concerning congestion.

As a result, the respondents gave several important elements/content which may be suitable to be presented to motorists. For example, some of the traffic messages were important in terms of influencing their decisions, e.g. time delays caused by congestion. In addition, local drivers also perceived length of congestion as important. Thus, both elements need to be included in future traffic messages concerning congestion. As a further point, it is worth mentioning that both types of element/contents are important to drivers in determining their decisions. Thus, systems developers should be able to develop messages that comprised both elements/aspects that have strategic value; i.e. reliable, credible and accurate as the traffic itself changes every minute. This also suggested that time and distance factor could be well-documented criteria/content that should be investigated further.

Another potential element is the suggestion to use alternate route recommended by the system. This message certainly would assist motorists. Motorists would prefer to have a solution to a problem, e.g. if there is congestion, they may need solution, i.e. alternate route to avoid congestion (as found in the experiments). However, other problems could occur by presenting this type of messages. For example, if all motorists receive the same message, e.g. follow diversion signs or use alternate route recommended by the systems, overreaction may occurs. Ben Akiva et al (1992) define overreaction as when drivers' reactions to traffic messages cause congestion to transfer from one road to another. In addition, as a result of presenting recommendation of alternate routes, a greater number of drivers may select to use the alternate route and consequently drivers with similar preferences will tend to concentrate on the same routes during the same time. Thus, the messages could potentially generate higher levels of traffic congestion.

However, one may argue regarding the above problems, e.g. overreaction and concentration. The impact of both factors may depend heavily of the quality of the traffic messages provided to drivers (e.g. Bonsall & May, 1986). Thus, the drivers have the choice whether or not to follow the suggestion of the systems. Indeed, the systems also should have better performance or capabilities in influencing drivers' behaviours such presenting accurate and credible information. Nevertheless, the study shows that several important elements/content that should be investigated further by using variety of types of method, e.g. subjective or objective types of data measurements. Thus, it could enrich the knowledge regarding the important element/contents that need to be included in the future traffic messages.

What kind of future traffic messages do drivers prefer?

As shown by the results concerning the traffic messages preferences, local drivers need to have more information. This could imply the importance of conveying more information to drivers. For example, drivers would like to have information on several facts concerning congestion details such as location, reason and how much time delay. Probably, this information would enable them to figure out/decide the severity of the incident, so that they can generate their own time estimates (e.g. Ng et al., 1997).

Local drivers also prefer that some of the messages be given to them as early as possible perhaps before their departure. This preference shows the importance of having some basic knowledge or information on the traffic condition before they go to their intended destinations. In a case of route choice, drivers would like to know which route is less congested. Thus, early presentation of the information that is prior to their departure may influenced their decisions, e.g. delay departure time, change mode transport or change route. Their preferences of having information to be presented early are clearly in accordance with previous works such as Spyridakis et al., (1991), Barfield et al., (1989) and Mannering et al., (1995). They all suggested that it is important to presenting some of the information as early as possible in order to influence drivers' decisions.

However, other problems arise. For example, Liable (1990) shows that messages of 4 information units (e.g. 'Traffic jams on A25') were recalled with 100% accuracy and 52% for the complex messages of 14-18 units. This shows that more information may affect the ability of drivers to remember the messages given to them. Thus, if the drivers' preferences were taken into consideration, e.g. conveying more information in the traffic messages, it is unlikely that they would remember/recalled the messages accurately. In addition, the ability of drivers to recall traffic messages depends on a number of factors including the display complexity (Liable, 1989), the modality of message presentation (Gatling, 1976) and the subject variables such as age and educational level (Liable, 1992). Therefore, the need to present more information may need to be resolved first by employing more objective types of research in order to be able to develop more strategic messages that comprised variety of element to be given to drivers.

Further, if different element were used, it would also cause a problem in terms of processing the information. For example, if too much criteria or element in the traffic message were given, drivers may not be able to interpret or understood the messages as shown in the VMS systems (e.g. Richards et al., 1978). Indeed, the use of verbal mode of information presentation could cause some problems such as in terms of perceptual capacities. Considerations must be given to such matters as clearness of auditory presentation under various conditions. Therefore, any further study need to resolve this issue before actually suggesting the development of variety of types of element in the future traffic messages concerning congestion.

In conclusion, the study served as a useful means of highlighting many of interesting insights for the designers of information systems. In general terms, the nature of trips may influence the behaviour/response and reason of the response taken by drivers. The study raises several issues. Firstly, concerning how such messages should be given to drivers. Although, in this study, verbal mode was used, the effectiveness could be argued or questionable because of the nature of the experiments itself which did not represent the true colours of traffic situation.

A further issue concerned the choice of modality used for presenting the variety of types of criteria based upon driver preferences. The presentation of information with variety of types of content/elements within the auditory modality may create unacceptable demands on driver memory. Indeed, other type of mode should also be used. Thus, one needs to investigate thoroughly these issues. Nevertheless, the study has highlighted some interesting findings regarding local drivers' response toward several issues investigated in this chapter. However, one must remember that the above findings are still based on subjective opinion and an objective testing is required to establish the actual response in real life traffic situation.

8.9. Chapter Conclusion

The chapter investigates several behavioural issues regarding the presentation of different traffic messages on congestion to drivers. Drivers were given six different types of traffic messages in two situations, e.g. home to work and vice versa. The study shows some useful and interesting insights for system designers to think when developing the actual traffic messages. The result clearly shows that drivers were influenced by the messages that were presented to them. In addition, traffic messages used in the study contained several important elements, which could influence drivers' decisions. For instance, time delay and length of congestion were considered important content / elements. Finally, drivers' preferences on traffic messages varied. They preferred to have more information rather than a single value of information. Thus, systems designers need to address the above issues before designing the actual systems to be use by end-users. However, the finding is not conclusive. Therefore, one needs to conduct more thorough study in examining drivers' behavioural reactions toward the presentation of traffic messages on congestion in several other setting such as simulators, road test and others. Nevertheless, the study has highlighted some interesting ideas regarding the presentation of verbal traffic messages on congestion.

Chapter 9: Discussion & Conclusion

9.1. Chapter Summary

This chapter provides a summary of the thesis. It also described the main objective of the study and its progression. It is also an attempt to synthesise and consolidate the main findings in order to arrive at a set of conclusions in relation to the general research question. Contributions to knowledge and paths for future research are indicated.

9.2. Introduction

This thesis aimed to explore and identify the information that drivers required in several situations in order to develop user centered information systems. Past studies revealed that drivers required various types of information, e.g. Streff & Wallace (1993), Tsai (1991) and Mannering et al., (1995). In addition, the study also intends to investigate the '*when*' and '*how*' questions related to the development of a drivers' information systems. These related questions need to be resolved before the systems goes into the use of the target audience. When reviewing past literature, many investigators have came out with various types of information that drivers required for several different settings, e.g. Wallace & Streff (1993), Tsai (1991) and others. The investigator has considered the question relating to the information requirements as important factors to explore especially as a first aspect to be investigated before developing the systems. This project is also interested in investigating new issues such as route choice criteria, route planning and wayfinding strategies used by the local motorists. Finally, it was the intention of the researcher to conduct a simple experiment aiming at exploring several behavioral issues relating of the presentation of traffic message to drivers. This research presented three studies involving a variety of different approaches. Chapter 4, 5, 6, 7, and 8 described the above aims which are covered in this research.

9.3. Summary of the Studies

In study 1 (preliminary studies), the main aim was to explore what kinds of information do drivers need. The specific objective was to examine the information that drivers need in several settings, e.g. congestion. The second objective was to identify the method and timing to present the information. Several kinds of approaches (e.g. focus group, exploratory interview, postal and interview survey) have been employed in order to come out with variety of response from respondents regarding the above aims. The findings of study 1 indicated that various types of information were required in several settings, e.g. congestion and unfamiliar trips. In addition, the timing to present the information also varied. The findings also revealed that most of the respondents prefer to receive the required information via the commercial radio. However, the results are not conclusive and therefore a main study was important in order to investigate driver information requirements.

The second study (interview survey) was carried out to extend the findings of study 1. This study aimed to answer several important questions regarding drivers' information requirements. For example, what kind of information does a driver required in several different settings, e.g. commuting and unfamiliar trips and during congestion or when deciding to divert to alternative route. 604 drivers participated in this study. They were interviewed in their houses in several districts in Kuala Lumpur. The findings of this interview survey showed that in different settings, drivers required different set of information. It was further found that all of the information might be related to the nature of the trips that were undertaken by the motorists. Another interesting feature found was that the timing of information to be presented to drivers also varied which is similar to the case in the study 1. It is perhaps related to the importance of the information that drivers required in each of the settings. In addition, the findings of the second study demonstrated the importance of commercial radio as the appropriate mode to present the information. This is also similar to the first study which found that commercial radio as the preferred mode to present the information.

The study also aimed at investigating several aspects that was never investigated in Malaysia. For instance, route choice criteria, route planning and wayfinding in unfamiliar settings. The second study revealed that various criteria were used in selecting a route in several different trips. The interesting output from this route choice study was that there were some similarities regarding the criteria use in several trips. For example, safety was the first important criteria indicated by respondents in all three types of journey purposes, e.g. home to work, work to home and unfamiliar trips. Whilst, in navigation study, e.g. route planning and wayfinding, the findings demonstrated that using maps was the preferred strategy by drivers in planning an unfamiliar journey and finding a way in unfamiliar environment. Nevertheless, there were also other strategies used by drivers in these route planning and wayfinding activities. An interesting point to note is the usage of more than one strategy in this navigation related activities. This imply that drivers did not stick to just one type of method.

The third and final study aimed to explore several issues concerning the presentation of traffic messages on congestion. An experiment was conducted to investigate drivers' responses when given several kinds of traffic information on congestion, important element that assist them to make decisions (i.e. response) and traffic information preferences. The findings show some interesting points for the information system designers to consider before developing the so-called intelligent system. For instance, most of the respondents prefer to have more information to be given to them regarding traffic messages on congestion. Factors such as travel time needs to be included in the future traffic messages on congestion.

9.4. Conclusions from the research findings

The previous section summarized the findings of the study. This study was conducted with the aims to answer several main questions that were important especially in Malaysia and in designing the so-called intelligent systems, e.g. Drivers Information Systems.

- What kind of information do drivers need?
- When to present the information?
- How to present the information?

The findings from this study have found that variety types of information were required in several types of journey purposes. Indeed, the information required was related to the nature of the task undertaken by the driver and trip purposes. For example, before deciding to divert to alternative route, drivers would require information on travel time between two routes e.g. their regular and alternative route. By providing this information, driver would be able to make better decision. This finding was concurrent with several previous studies such as Wallace & Streff (1993) that demonstrated the relationship between the information required with the trip undertaken by the motorists. In addition, some of the information needed in one trip was also required in other trip. Thus, it may suggest that the information is very important in assisting drivers' decisions. The information required were also similar both in the Study 1 (preliminary) and Study 2 (main study). This may refer to the highly important information required by the drivers. The findings also demonstrated the similarity of information required between the experienced and inexperienced drivers regarding the information needed while travelling to unfamiliar destinations. This may refer to the similar need between the two groups concerning the information they needed. However, one of the interesting features of this study was there is also a difference between gender and age group regarding the requirements of certain information in certain trips. For example, female drivers would prefer more information on congestion than male drivers while making trips to home from work.

In terms of the question regarding when to present the information to the target users - the answer depends upon the need of the drivers. The findings of the study 1 and 2 clearly revealed that there is various timing appropriate to present the information. For example, the information should be given before the trip, during and after the trip. However, one question arise especially when the study investigated the subjective opinion of the respondents which is different than by using the available systems or objective measures such as simple laboratory experiment or road trials with the information systems in it. This also could be true regarding the possible method to present the information. The result demonstrated the preference toward commercial radio rather than other types of medium such as RDS-TMC, in-vehicle information systems unit and others.

As mentioned earlier, most of the respondents participated in the study were familiar and has experienced being informed by several commercial radio station around Kuala Lumpur. Thus, they may liken the idea of being given traffic messages from a commercial radio. Thus, it may influence the findings of the study. However, past studies have revealed that majority of the drivers prefer commercial radio as their source of information (e.g. Spyridakis et al., 1991; Streff & Wallace, 1993). Nevertheless, the findings of this study should be treated with caution especially when a majority of the respondents did not know or even experienced most of the information systems listed in the questionnaire such as RDS-TMC, VMS, in-vehicle information systems.

The findings clearly demonstrated some interesting points for system designers to ponder upon before actually developing the intelligent systems. However, it cannot be said from the research findings that these are the information that drivers would require when making commuting trips or before deciding to divert to alternative route. The results are only clear or applicable in the local context which may be different to the other countries such as Japan, the U.K or U.S. Thus, the information could be culturally- influenced. However, as reported by other studies, there were also some similarities regarding the information requirement. For instance, information that drivers required in Penttinen et al (1996), Mannering et al (1995) Wallace and Streff (1993) and Tsai (1991) study were also similar with this study. It is perhaps the importance of the information as perceived by the drivers. For example, information on congestion, weather and others could be regarded as universal and important for most of the drivers. Therefore, we could suggest that there are some information which is important for drivers that need to be taken into account by system designers when developing the information systems.

Beside the above principal aims mentioned earlier, the study is also interested to answer several other questions set in this thesis, for example;

- How local drivers plan their unfamiliar journey and find their way while driving to unfamiliar destination?

Similar to the several past studies, the answer to the above questions was varied. In other words, local drivers would employ several kinds of strategies for route planning and wayfinding on unfamiliar destination. These findings clearly supported several studies such as Abdel-Alty et al., (1997), Obata et al (1993), Gordon & Wood (1970) that demonstrated the above results.
In terms of the users preferences, maps were the most employed strategy for route planning and wayfinding activities. This demonstrated the importance of map usage for drivers in assisting them in navigation related problems. Past studies also revealed the significant of maps usage in helping drivers (e.g. Stretter & Vitello, 1985). Nevertheless, Burnett (1998) also found that maps also cause several problems such as maps misinterpretation by drivers. Thus, this study found that on average, local drivers would used four different types of strategies in order to plan their unfamiliar trips and find their way while navigating in an unfamiliar environments. Thus, we could assume that by using variety of types of strategies would enhance drivers' performance and capability to reach their destination. Unfortunately, the study did not investigate or measure the

performance of drivers while using the variety of strategies mentioned earlier. Indeed, Burns (1997) also pointed out that not only the strategies would assist drivers they also may bring some disadvantages such as getting lost and feel embarrassed when they could not find their intended destination.

One of the interesting features of this thesis is the use of passer-by in helping drivers to tackle their navigation related-problem - route planning and wayfinding. Past studies revealed the extensive use of this kind of strategies employed by first time drivers when navigating to unfamiliar destinations (e.g. Gordon & Wood, 1970; Burnett, 1998). Thus, it demonstrated the significance of this strategy for navigation activities. The interesting point here is that local drivers also would employ similar strategy even though the situation or scenario is different. People around the world employ the usage of passer-by (e.g. asking someone for the route information). Therefore, we could assume that this strategy is one of the important methods employed by people not only by motorists but also others such as pedestrians and cyclists (e.g. Bovy & Stern, 1990).

The results clearly defined several interesting points for system designer to contemplate. For example, is it better to provide an extensive map database for drivers for their navigation activities? The findings clearly demonstrate the preferences of map usage for both navigation activities - route planning and wayfinding. However, one may argue this point. It is because drivers would also use other types of strategies in their navigation-related activities. Thus, we could assume that the information systems should have several functions that suit drivers' needs and preferences of which types of strategies to use. In other words, the systems only provide the relevant information but the control is on the part of the users who will determine the decision. Nevertheless, it cannot be said from the findings that variety of types of information should be stored for the use of its end users. The results are only pure subjective preferences without being supported by empirical evidents such as measurement of performance by using objective technique such as simulation or road trials.

The study was also interested to explore new areas which is not fully investigated by local investigators such as:

- What kinds of criteria were used in selecting a route?

To answer to the above question the study had demonstrated the usage of a variety of criteria in selecting a route in three different types of journey purposes, e.g. home to work, work to home and unfamiliar trips. This result also supported several past studies which also revealed the need to have several types of criteria in route selection process (e.g. King, 1986; Abdel-Alty, 1997). The study also supported the difficulty in arriving at a universal conclusion regarding the suitable criteria for route selection (e.g. Bovy & Stern, 1990). However, one could suggest that the criteria employed by local drivers were related to the nature of the trip undertaken by them. This may suggest that trip characteristics may influence route choice criteria.

In an attempt to select a route, drivers would use numerous criteria in formulating a route such as travel time, safety, distance and other factors. In addition to these factors, drivers also would use other aspects such as their experiences, habits, cognitive limits and other behavioural consideration which may produce variations in route selection. Thus, a driver would prefer criteria whilst others prefer the others. For example, one driver may perceive travel time as the most important whilst another driver may prefer safety as his important criteria to select a route. Abkowitz (1981) have showed the difficulty faced by commuters at the beginning of their trips. This difficulty would cause trouble to drivers especially when they failed to select a suitable route. For instance, Wachs (1968) and Benshoof (1970) have showed that drivers failed to find the fastest route because of the different interpretation of what fastest route may constitute. This brought about some interesting points for system designers in designing route navigation systems. The systems should be able provide a logical explanation to drivers regarding the criteria choose for drivers (e.g. van Winsum, 1993). However, this issue needs to explore drivers' needs which relate to the reasons why car drivers prefer some route over another.

The findings also revealed that the drivers sometime would use their own subjective evaluation of the criteria that is suitable in selecting a route. In fact, van Winsum (1993) also demonstrated similar findings. He pointed out that driving experience did not influence the subjective importance of route choice criteria in a meaningful fashion. The selection of variety of criteria proved that there is the need for drivers to have more information before they actually select a route. Thus, the systems should be able to provide a variety of information from which drivers would choose.

In terms of the user preference measures, safety, saving mileage and avoiding congested route were the most preferred picks by drivers in selecting a route. Thus, these three criteria were considered important especially when making route selection. However, this is not to suggest that other types of criteria were not important for drivers. Van Winsum (1993) clearly stated that criteria were not independent on each other. Therefore, safety criteria could be substituted with other types of criteria if drivers are faced with other situation which demanded different criteria. Hall (1992) revealed that sometimes drivers would change their criteria of route selection if they have to do it, for instance, when they are faced with changes in the route network. He called this process as "adaptive route choice" which happened while drivers are en route to their destinations.

However, the results cannot be concluded as being applicable to other situations in different countries or even among the same respondents. It is because the different nature in which the aspects were investigated. Thus, the findings may not be sufficiently reliable to represent local motorists' population route choice criteria because the results were merely subjective opinions which lacks empirical evidence to support it.

Finally, the thesis is also interested to answer several behavioural issues relating the presentation of traffic messages on congestion (Study 3). It is a first attempt to explore:

- What are drivers' reaction and reasons for their action?
- What are the important elements of traffic messages on congestion?
- What are drivers' preferences for future traffic messages on congestion?

The findings of the experimental works revealed that different types of traffic messages were interpreted differently by individual driver. Thus, it is suggested that variety of element contained in the traffic messages on congestion would have various types of actions taken by drivers. It highlighted the need to present information which is according to the needs of the drivers and their trip purposes. In addition to the different interpretation made by motorists, the findings also demonstrated the need for important elements to be included in the traffic messages. It is because most of the subjects in the experiment perceived that some of the important elements that contained in the traffic messages could influenced their decision making process. For example, a message that presented the time delay caused by congestion perhaps could affect their decisions whether to stay on the same congested route or diverting to alternative route. In addition, the suggestion to use alternative route given by the information systems also proved that some drivers may need some assistance in their decision making activities. Thus, system designers should be able to develop the so-called drivers' support system that could provide some assistance or secondary information just to confirm their decisions. This is another task that need careful consideration and a thorough examination.

One of the interesting points revealed in this experimental works is that the need for more information contained in the future traffic messages on congestion. In other words, drivers would like to have more information rather than just a single value of message. For example, most of the participants in the study perceived the importance of the messages concerning congestion and its related information such as location, condition/severity and others. In addition, travel time should also be included in the future traffic messages on congestion. Thus, it is suggested that there were two themes considered to be important to the drivers. Therefore, system designers should develop some systems that are credible in terms of providing accurate information to its end users. Ben Akiva et al (1992) and Kantowitz et al (1997) have shown that in order to attract the users to use the information systems, it should be able to convey messages which are reliable, credible and accurate. The experimental works have come out with several new evidents relating to the presentation of traffic messages on congestion. However, the findings are not conclusive. It is only applicable to the subjects participated in the study. Thus, it cannot be concluded that the results could be use in other countries such as the U.S. or Japan. It is because most of the results gathered in the study were merely subjective opinions which lacked objective measures and reported data.

9.5. Implications for the design of Driver Information Systems

The research presented here brought out evidents about the nature of drivers' information requirements. In this section, the findings will be discussed and how they can be related to the development of drivers' information systems. Firstly, this study provides some evidents about driver information requirements which varied, as they were found to be related to the individual drivers information requirement needs and his or her journey purposes. In addition, drivers also required several kinds of information (e.g. at least five information) for different types of journey purposes, e.g. from home to work and work to home. Indeed, the study also revealed that different types of journey prompted the need for different kinds of information. The main finding is that some of the information required was similar in spite of the fact that the journey purposes were different. This may suggest the importance of the information in influencing drivers' decision. The findings of Study 1 and Study 2 showed consistent results in terms of the requirements of several information which were needed even though the journey purposes were different, e.g. to home and to work.

The findings appear to support several past studies that demonstrated the need of variety types of information and the similarities of information requirements even if the journey purposes were different (e.g. Wallace & Streff, 1993; Penttinen et al, 1996; Tsai, 1991). As these studies suggested that the need for variety of information revealed the different need of individual driver regarding their information requirements (e.g. Mannering et al. 1995; Barfield et al., 1991 and Spyridakis et al, 1991). The information required was also related to the nature of the task undertaken by the motorists. For example, in deciding whether to divert to alternative route, drivers would prefer to know in advance several types of information that could help them to make a decision whether to divert or not. This also supported by the study of Streff & Wallace (1993) that also found that there is an association between the information required and task undertaken by the driver. Thus, the evidents provided in this research constituted several important facts that systems designers should consider in developing the information systems. For example, the systems should have different types of information stored in its databases. In addition, the systems also should distinguish the different needs or knowledge when designing the systems. It is because drivers themselves have different abilities in terms of operating the systems. Thus, systems designers should be able to develop error-free systems which is easy to interpret and comprehend.

Apart from the above insights, system designers also need to design a system with variety range of function which end users could find useful such as yellow pages or map information that could assist drivers' decisions. As mentioned earlier, the systems should be able to differentiate diverse needs of drivers. This also include language selection, format to present the information, content or structure of the information. The message should be understandable, easily recognized and simple. The findings also revealed the need of some sort of assistance such as support systems. Thus, system designers need to develop support systems within the driver information systems that could acknowledge decision taken by drivers based upon the information presented to them by the intelligent system.

Secondly, the study also suggested some evidents about the timing and method to present the information and their implications for information systems developments. There were several important aspects identified that could influence the nature of timing for presenting the information. First, a driver may benefit from three timing of information presentation, e.g. pre-trip, en-route and both (e.g. pre-trip and en-route). Past studies revealed the various findings regarding the appropriate timing to present the information that users required. For example, Spyridakis et al (1991) found that some of the information should be given before the trips to assist drivers in making decisions and during the trips if there is changes that drivers have to face while en-route to their destination. Whilst others such as Tsai (1991) argued that the timing should be precise in order for drivers to be able to make accurate decision. Second, most of the drivers prefer to receive their information from commercial radio compared to other types of mode of information presentation. The implication of the findings may suggest that the intended systems must be able to present variety of information, e.g. wide range of information and drivers must have a control or freedom to choose what, (e.g. what information is needed), when (e.g. when is it necessary to be present the information) and how (e.g. in what mode to present the information).

Third, by for design consideration, the information systems should also have a variety of function and could change according to drivers' needs/requirements of information. In addition, the information systems should also need to consider drivers' information processing capacity limitation and other human factors issues such as response and interface before developing the information systems. However, the information systems also should be based upon drivers' needs/requirements, e.g. user centered information systems. Fourth, with respect to design implications, the results showed an interesting point regarding the suitable method to present the information. Most of the respondents would prefer to receive traffic information from verbal mode of information presentation, e.g. commercial radio compared to other types of mode. In this case, system designers have a lot of work to do especially to design the appropriate mode of information presentation. In addition, system designers should also bear in mind the three fundamental questions such as what, when and how if they were to design the systems. These three questions are related to each other. Thus, in developing the intelligent systems, designers have to carefully consider all the factors related to the development the information systems.

System designers could design some sort of information systems that have dual or more than one capability such as map and verbal or visual and speech systems. It is because the findings of past studies did not arrive at the same conclusion regarding the appropriate mode to present the information. In addition, the list of information as generated (Table 9.1) by this study gives an idea of the range of information that may be appropriate for presentation within an information systems (combination of map, speech or others). Another interesting finding for system designers concerning the design implication of information systems especially route guidance/navigation system is regarding the strategy used by drivers in several unfamiliar destinations. The findings has highlighted several interesting ideas such as the use of map for navigation strategies which may suggest the need to provide end users with variety of route knowledge stored in the memory banks of navigation systems. However, there are a large number of difficulties regarding the use of maps for navigation. For instance, some drivers misinterpreted the presented layout of complex junctions (e.g. roundabouts) within maps. This problem illustrating the importance of other types of mode to assist drivers in navigation related activities. For example, it can include well-designed map displays to supplement the verbal or speech for route guidance systems.

As mentioned earlier, most drivers consulted maps to plan their routes. Thus by improving road or city maps might assist route planning and wayfinding. This approach could be a fast and relatively inexpensive solution to navigation problems. For instance, Bell (1997) has suggested that route knowledge acquisition could be improved with segmented strip maps. In addition, the findings also revealed the usage of more than one strategy for navigation related activities. This suggested the need for system designers to develop a route guidance system which offers in-vehicle solutions to wayfinding problems by providing a database that contained variety of type of information. For example, the system could help reduce uncertainty by displaying main and additional information or by supplementing environmental information which is perceived by drivers as a major contributing factor to navigate behaviour and performance.

Based upon the results of this research and other past studies, system designers should remember several interesting points before designing the information systems. For instance, although maps were the main strategies used by drivers, some past studies concluded that electronic maps should not be used because they did not demonstrate any superiority in performance or safety advantages (e.g. Wierwille et al., 1988). However, electronic maps have high potential of presenting pre-trip planning information. For example, the electronic maps can assist in the selection of routes and provide good overview of routes. Thus, the system designers should be able to design a system that could have several mode of functions such as electronic map for pre-trip planning and other types such as speech or combination of direction symbols and verbal instructions for the use of its end users.

The system designers also need to bear in their mind that attempts to develop an information display that will successfully address all drivers' navigational information needs across situations would be difficult. Thus, designers need to examine the different aspects of navigation task. Consequently, different display should be used to match the different situations and information needs of the user. For example, pre-transit display or display while the vehicle is stopped can have the full attention of the users whereas in-transit display must require minimal amounts of attention.

With respect to the decision making stage of navigational task, route guidance system should make many decisions for the driver. For example, the system should give the driver the direction and location of each manoeuvre. The driver would then match the instructions or decisions to a location in their forward view and execute the manoeuvres. The route guidance system could help in selecting routes that have fewer and less complex decision points. Furthermore, the system should give precise and easily handled indications about the directions to follow at each driver's decision points.

Apart from assisting the navigational task such as route planning and wayfinding activities, route guidance system should also play another important role which is to select the best route from an origin to a destination. The findings clearly demonstrated that the design implications from route choice criteria study showed that drivers would employ different types of criteria in selecting a route other than time or distance. Thus, the intended information systems should be able to guide drivers to choose a route based upon criteria which drivers found important and crucial based upon their information needs. In addition, the systems should also must have variety of function and capabilities in selecting a route for drivers to use. However, drivers must have control in deciding whether to use the route.

Route choice is a complex decision process that involves the consideration of many factors and the selection of one of many alternatives (Jovanis & Kitamura, 1989). Although, previous studies such as Cross & McGrath (1977) concluded that motorists would use several types of criteria to select a route, system designers need also to consider the diverse information needs of drivers who would then use the information systems. Thus, it is a challenging task for system designers to develop a system that could distinguish the needs of drivers and different types of journey purposes. This implies the need to develop a route guidance system that is capable of presenting information and at the same time, providing some rationale behind the information presented.

System designers should also need to consider other factors such as the accuracy of the information presented to the end users. Kantowitz et al (1997) and Ben Akiva et al (1992) have argued this issue which need to be investigated thoroughly before developing the route guidance systems. The issue of accuracy of the information presented to the end users is important because drivers sometime believe that the advise routes conveyed by the system is not appropriate for them, either because of 'gaps' in the guidance system knowledge of the network or of up-to-the-minute traffic conditions or the system and the user have different routing criteria (e.g. Bonsall, 1992). Consequently, in order to ensure a high level of user acceptance, the route selection logic should be the same as the decision logic of the user of the system. Van Winsum (1993) suggest that the guidance system would work best if the driver is led over routes he would have selected with a full knowledge of all available routes. Thus, it is paramount to know that the driver need which relate to the reasons why they prefer some routes over other routes.

The system for route choice should also be incorporate in the route guidance system as the task is also similar with the navigational task. Indeed, some of the available route guidance systems offer assistance to direct drivers along routes that are easier to negotiate. They also could select routes that have fewer and less complex decision points. If the systems were linked to traffic control network, they could re-direct drivers to avoid heavy traffic conditions. Thus, the route guidance system should have the knowledge of wide range of route network and driver's representation of the driving environment, e.g. route. System designers should also need to consider a function within the route guidance system that could broaden driver's cognitive route choice set which aimed at minimising costs or time of route choice criteria that selected by the driver.

The results of this research also provide some interesting points to ponder for system designers especially regarding the presentation of traffic messages on congestion. For instance, the need for system designers to give several facts on congestion that need combine with several important elements perceived by drivers as important in making decisions. It is because several important elements such as time delay or congestion facts may influence drivers' decisions. Indeed, Ng et al (1997) also suggest that motorists who wanted the facts about congestion such as causes or reasons of congestion or delay may assist them to decide the severity of an incident so they could generate their own time estimate. Thus, it is important to present more information or facts to end-users.

System designers also must be able to develop an information system that could provide accurate messages on congestion based upon real-time traffic condition. For instance, important elements such travel time need to be included when developing traffic information on congestion. Thus, designers of information systems should be able to provide more information on congestion (e.g. real time information) and should leave the control of the systems to the drivers.

Apart form that; it is apparent that the results showed that drivers may interpret the messages differently based upon their need and journey purposes. Thus, the intended systems should concentrate upon modifying driver's behaviour or decision making. It is a challenging task for system designer to give some supplementing information for drivers to act upon it. In addition, it is better for the systems to give accurate predictions regarding the messages presented to the users.

Another important task for system designer to consider is the timing of the information to be given to its end users. The findings revealed that some of the messages should be given early before departing to the destination. Thus, the timing of the messages could influence drivers' decisions. The system must be able to present the information at the right time and based upon the driver need. It is because many of the available and current systems tend to increase drivers' workload due to the inappropriate messages timing (e.g. Ashby et al., 1991). Systems designers also have another important task which is to ensure that the advance information system has a function that could give drivers some control in selecting certain type of information that suit their need and journey purposes. A selection function or control is necessary since human capacity to process information is limited and the amount of information presented to the drivers is enormously large.

Besides the aforementioned design implication of the drivers information systems, system designers also need to consider several important aspects in designing the intelligent systems. For instance, the demands on drivers' resources is associated with the introduction of advanced technology into their vehicles. Factors such as visual resource should be taken into consideration since 90% of all information that drivers use for the primary task of driving is obtained visually (Rockwell, 1972). In addition, there is also a cognitive component associated with the primary task of driving. For example, cognitive load can occur when one attempts to find the best route on a computerized map display within the vehicle or when attempting to interpret confusing route or direction signs in the forward view. This load can result in perceptual narrowing and temporary rejection of apparently irrelevant stimulus information (e.g. Moray, 1981). Indeed, cognitive load also could temporarily suppressed visual scanning which may be needed for hazard detection. Thus, system designers need to consider both of these factors before introducing the intelligent systems for the use of target users.

Besides factors such as visual and cognitive resources, system designers also need to take into account the individual differences in drivers' abilities (e.g. vision, hearing, spatial skills); experience (of driving and localities); and special needs (e.g. physical or perceptual impairments). These elements will influence both the input devices and the design of the information presented. In addition, some previous studies indicated that even the drivers who used the intelligent systems have different opinion regarding the use of information systems in their vehicles. For example, Watling and van Vuren (1993) found that drivers' responses were different although they were given the same type of information. This assumption was also found in this study especially in the experimental works where drivers interpreted the messages differently according to their characteristics and types of journey. In other words, system designer may need to consider the variety of types of drivers' characteristics in order to satisfy their need for the so-called intelligent systems.

One of the important aspects regarding the introduction of intelligent systems in today's vehicles is person-machine interface. This aspect has not been fully addressed both by human factor specialists, engineers and system designers. The aspect covers the way in which the driver uses and responds to the information systems device. It is found that most of the studies reported in this area have been related to driver's distraction and other safety issues. Thus, more study is needed in order to understand how driver uses and respond to the intelligent device. For example, one of the reported study in the literature revealed that in spite of having to decide to follow the recommendations displayed on the guidance device, a driver may still unintentionally leave the route by misinterpreting the information provided. In addition, Ben-Akiva et al., (1992) have pointed out that a driver is unable to process the information provided or is distracted by the amount of information available.

Furthermore, the issue of driver-vehicle interaction in terms of who control the systems also need to be examine. This aspect is one of the essential issues that need to be considered as early as possible before developing the systems. For example, system designers need to consider questions such as will the device tell the driver of status conditions (as a speedometer does) or the system just does what it does best without informing the drivers. If it were so, would the driver obey the information given by the systems? These are some of the issue that needs to be given due consideration by the designers especially for the acceptability and safety of the device for the use of its end users.

System designers need to consider various factors/aspects that are related to human as the user of the systems, route network, environments and system capabilities when designing the information systems. For example, information processing and decision making varied greatly within the driver's population. Thus, it is a challenge for designers whether he or she is a human factor specialists, engineers or systems designer to ensure that the intelligent devices can be used effectively by a variety of people for whom they are intended for. As mentioned earlier, these factors were related, i.e. all of the factors should be given full attention before the system goes into the market for the use of target users

Apart from the aforementioned aspects that need to be consider by system designers, the research also highlights the importance of several types of information to be given in certain types of journey. The central question of interest of this study has been: what kind of information that drivers required for different task or journey purposes. Importantly, several important outputs emerge as a result of this synthesis:

- A list of pool of information elements of potential use in supporting the variety types of drivers' journey purposes. In Chapter 6 subjects listed a different range of information that they required for different types of journey. The results formed the basis for a detailed categorization scheme for information elements. This list can also be seen as a 'pool' of information that could potentially be presented by the drivers' information systems to support the drivers' task.

Based upon previous studies, some of the information listed in the pool was supported by several past researches that aimed to investigate drivers' information requirements. Thus, by using the categories as shown in the above table highlighted the kind of information drivers need in several types of journey purposes. In addition, it also enhance the knowledge regarding the information that should be given to drivers if one intends to design the intelligent systems for the use of its end users.

Table 9.1 Categorization scheme for information requirements

Types of Information	Types of Journey Purposes
Congestion, Alternative route Route guidance, Parking guidance & Traffic state prediction	Commuting trips to and from work
Condition of congestion, Alternative Route & location of congestion	Dealing with congestion whilst maki commuting trips to and from work
Length of alternative route, Congestion on usual route	Deciding to divert to alternative rout whilst making commuting trips to & from work
Route guidance, traffic condition, Alternative route & Congestion	When making a trip to unfamiliar Destination

In addition, the suitability of information elements (e.g. taken from the pool of potential information) for presentation by a drivers' information system can be evaluated based upon the task or journey purposes. In this thesis, the term 'suitability' can be said to refer to how well the information allows drivers to achieve their goals, e.g. arriving at their destination or diverting to alternative route.

The background literature (Chapter 3) clearly demonstrated the need of several different types of information in order to support their driving task. In addition, the requirements of several types of information revealed in the Table 9.1 also mirror some of the information required by others in past studies such as Streff & Wallace (1993), Tsai (1991), Mannering et al., (1995) and Penttinen et al., (1996). This may suggest the importance of these types of information in assisting drivers to achieve their goals. For example, Wallace & Streff (1993) concluded that approximately 33 bits of traffic information were needed in order to decide whether to divert to alternative route. Indeed, some of the information was concordance with the information required by local drivers. Thus, we could suggest that some of the information are similar even though in different context such as Malaysia vs. U.S. Besides, the information that drivers required in advance in order to decide whether to divert to alternative route could be used as pre-trip or en route type of information presentation. Indeed, some of the information need to be presented as early as possible and this clearly demonstrated the preference of motorists to have some information in advance before making their decisions (also found in the study by Wallace & Streff, 1993; Spyridakis et la. 1991).

The results of this study (in particular, chapter 4 and 6), and the supporting literature such as Kantowitz et al., (1997) suggest that some of the drivers need to have some assurance regarding the information given to them especially based upon the above table (Table 9.1). It is felt that system designers should concentrate on this issue more thoroughly. This is because if the system is to attract a large number of users it must have reliable sources of information to be given to its end users (Kantowitz et al., 1997). Indeed, there should also be some sort of confirmation from the system itself for drivers in order to inform them regarding their action that has been taken. In addition, certain type of information should be given as an aid to drivers' decisions. For example regarding the information on parking spaces, the systems should present an accurate and reliable type of information in order for drivers to use it.

Finally, it is possible to propose a wider, more useful range of information elements. Figure 9.1 demonstrates, using the example of congestion information, how the original list of information elements is transformed.

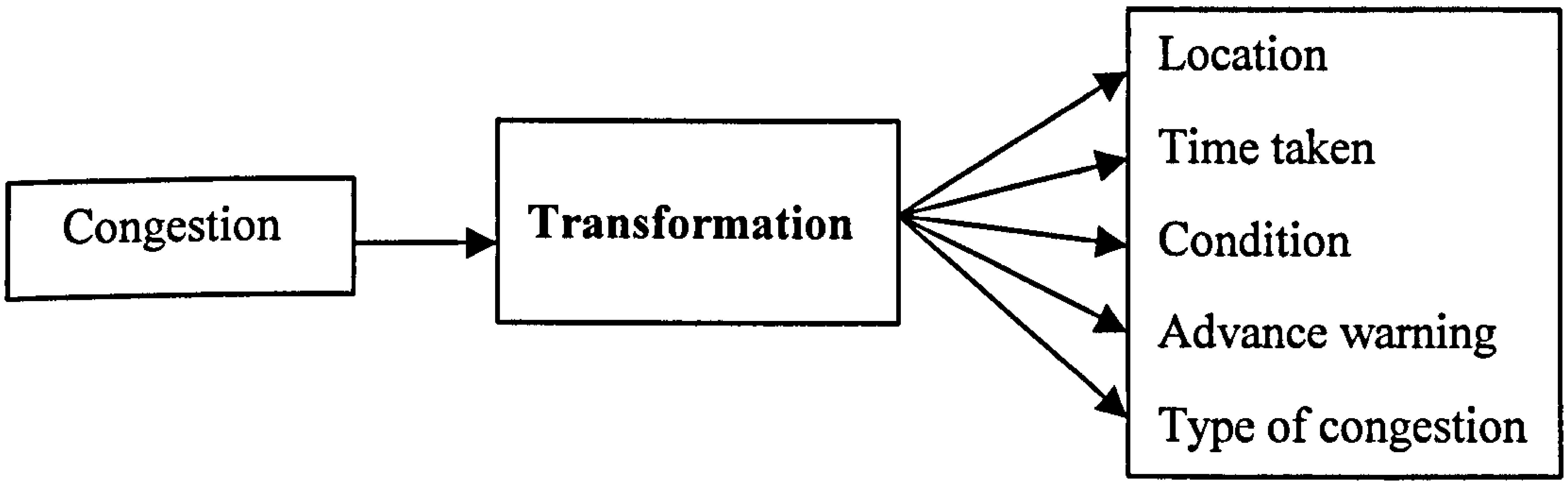


Figure 9.1 - Examples of the transformation of information elements

The above transformation process certainly would assist system designers in terms of providing traffic information to drivers. For example, information on congestion could be given in several terms or aspects such as location, time taken, condition and other. However, this does not mean that the pool (Table 9.1) and the above transformation process (Figure 9.1) is complete, rather that there is a need to investigate thoroughly regarding both aspects. Variety of types of approach such as simple survey with drivers, laboratory simulation and on road trials would seem to be the appropriate means of achieving the aim.

Beside the information that should be given on certain trips, the research also presented several interesting points for the consideration of system designers in designing the future traffic messages of congestion to be given to the target users. Based upon the results of Chapter 8, some issue has been brought up, for instance:

- A specification of the information elements that should be given to the motorists regarding traffic message concerning congestion. In Chapter 8, respondents gave several important elements in the traffic message and their information preference.

Table 9.2-Some suggestions for future traffic message concerning congestion

Category of traffic message	Suggestion for future traffic message
Congestion Ahead	Fact about congestion/delay, e.g. time delay Should offer alternative Presented as pre-trip information
Congestion Ahead-Delay 1 hour	Offer alternative Given as pre-trip information Facts about congestion, e.g. location
Congestion Ahead - 3 km	Offer alternative Facts about congestion, e.g. causes Presented as pre-trip information
Congestion Ahead - Follow diversion signs	Travel time (using the suggested route) Offer other alternative Presented as pre-trip information Facts about suggested route, e.g. distance
Congestion Ahead - Follow diversion signs- Delay 1 hour	Travel time (arriving at destination) Facts about delay, e.g. condition/causes Presented as pre-trip information
Congestion Ahead - Follow diversion signs- 3 km	Travel time (using the suggested route) Presented as pre-trip information

An indication from the table shows that there are variety of elements that need to be considered by system designers especially when designing future traffic messages on congestion. The table clearly demonstrated that different types of information are likely to elicit different responses (as found in the experimental works) and the need for other important element in order to assist driver decision making process. This process was also influence by the characteristics of the driver. For example, most of the respondents prefer to have all the information presented to them as early as possible, e.g. as a pre-trip information. Stephens (1990) has shown that given a pre-trip information could better advice drivers. Pre-trip information can influence mode and/or destination choice. Mahmassani and Chen (1991) also pointed out similar findings. In fact, others such as Spyridakis et al., (1991) also suggested that there are some benefits that could be conveyed to drivers if some of the information were given as early as possible. Nevertheless, this issue is related to the notion of timing to present the information.

Apart from the need for pre-trip information, system designers need to give full attention of the need to present some alternative or solution to the target users. For example, when presented messages such as " there's congestion ahead", the system should be able to present some sort of assistance such as the use alternative route recommended by the device whether it be in-vehicle or outside vehicle. However, as pointed out by Ben -Akiva et al., (1991) sometimes drivers misjudged the information given to them possibly due to their limited knowledge about the route network or they were distracted by too much information given to them. These issues need to be resolved. By presenting too much information may burden driver's cognitive resources and they fail to make better decision. Nevertheless, drivers would require some sort of assistance. Therefore, it is a challenge for system designers to design what kind of assistance that is appropriate for the use of motorists.

With respect to design implications, system designers also need to have a good knowledge regarding the presentation of congestion/delay facts and time to the end users that will use the device. The table clearly shows that information concerning congestion such as time delay caused by congestion, location of congestion and causes of congestion need to be given directly to users. As pointed out in Figure 9.1, information on congestion could transform to various types of information which should be used by drivers in making better decision concerning their journey. Systems designers should consider this issue especially when presenting facts about congestion to the target users. It is because the information given to the drivers may distract them especially when they have to observe too much information within the same setting.

Besides that, the issue of timing also needs to take into account when designing future traffic messages. Table 9.2 revealed the need for travel time whether it is a journey prediction time or otherwise. Drivers would believe the system if the information given to them is reliable (e.g. Kantowitz et al., 1997). Thus, it is a challenge for system designers to develop a system that is able to present not only the information but also reliable in terms of influencing drivers decision. For example, in presenting information concerning the recommendation to use alternative route, the systems should be able to give precise information regarding the distance of the alternative route and travel time. It is because drivers have been shown to be resistant to diverting from their present route to avoid congestion (Dudek, 1980). It is also similar with the result of the experimental works that some drivers would rather be stuck on their congested route rather than to divert to alternative route. This unwillingness to detour may be dependent on detour knowledge of the drivers. One of the keys to persuading drivers to use an alternate route is conveying to them the appropriate and timely information (Dingus & Hulse, 1993).

The study has highlighted some of the issues that need to be taken into account by system designers especially when designing traffic messages on congestion to be presented to the target users. However, this list is not conclusive. Hence there is a need to explore more regarding this issue before we could become clear what kind of information or important elements that should be given to drivers in assisting them while driving.

9.6. What contributions has the studies made?

The central aim of this thesis is to identify information that a driver required in several different types of journey purposes. A review of past literature related to the drivers information requirement shows an enormous amount of research has been conducted over the years specifically in the 1960s up to 1990s. Most of this research has been concerned with the development of the so-called intelligent systems for the usage of drivers. Indeed, most of the systems have already been used by the target users compared to this study, of which the system is yet to be made available in local market, e.g. Malaysia. Although, there are a number of studies relating to information requirements, very little information has been added to it regarding the information needs of other drivers from developing countries such as Malaysia which has been predicted to be different compared to developed countries such as the U.S., U.K., Japan or Europe. Some of the contributions made by this study were highlighted below.

- This thesis contributes information on user preference toward information that they required in several different types of journey.

It has been found that drivers would highly value information that could help them to determine their decision. The thesis shows that drivers' needs for information varied according to their needs and journey purposes. For example, when deciding whether to divert to alternative route, drivers would like to have in advance some of the information that could help or influence them in decision making process. By giving the information early, they are able to make accurate decision. Nevertheless, other factors are also present at the time drivers make decisions such as traffic density and others.

The thesis provides some interesting findings to the overall knowledge regarding drivers' information needs. Thus, it is important for system designers to contemplate these various kind of information needed by drivers before the information system goes into production line. In addition, it is also believed that the study reported in this thesis could be contributed to the Ministry of Transportation and the Malaysian Traffic Police. It is also could help both parties to gain greater knowledge on Malaysian driver's behaviour/information requirements where there have been no study reported in local scenario.

In addition, the study may contribute to enhance greater knowledge regarding drivers' information requirements. For example, drivers require information in several situations, e.g. when deciding to divert to alternative route or dealing with congestion. In addition, the study is able to give greater insights on the local drivers' information requirements. Other benefit of the study is that it could be used in comparing with other drivers in other countries such as Europe, Japan or the US. It was predicted that there must be some distinction in drivers' information requirements.

It is also believed that the thesis contributes to the knowledge within the fields of transport psychology/human factors. Driver information requirements varied depending upon their needs and their journey purposes. The variety of information requirements indicated by drivers may reflect the importance of the information in assisting drivers' decision making and behaviours. System designers could use this information in designing the intelligent systems. One of the interesting feature of this study which were in line with the other previous works is that it confirmed the notion that suggest motorists population cannot be considered as a homogenous population which have similar information needs. This has been clearly identified in this research.

- The thesis shows that the appropriate timing and mode to present the information varied.

In this study, it has been found that drivers' information requirements were also related to the timing and mode to present the information. However, both aspects, e.g. timing and mode to present the information were based upon subjective evaluation/measures which could be questioned. Nevertheless, several past studies confirmed the findings of this research concerning the mode and timing of information presentation. For instance, Spyridakis et al., (1991) reported favourable users' preference toward the usage of commercial radio as the main mode to present the information. In addition, the results on the timing of information presentation could also assist systems designers in presenting timeliness traffic information which could influence/help them in their driving task. The issue such as timeliness and accurateness of information were also given priority by several investigators such as Kantowitz et al., (1997) that he mentioned users' confidence will fall if the systems is not reliable or the information given is not accurate.

- The study found that drivers would employs map when making several navigational activities such as planning and finding their way in unfamiliar journey.

This suggests that maps could help drivers in their unfamiliar journey. No study is yet available or reported regarding motorists' navigational strategies especially in Kuala Lumpur, Malaysia. This thesis could contribute to the knowledge of local researchers and others enthusiastic research communities regarding the issue In addition, this knowledge could contribute to the developments of some mechanisms or systems in helping drivers, e.g. route guidance systems. Thus, the study could be one of the starting points especially in Malaysia regarding route planning and wayfinding strategies.

Nevertheless, past researchers have shown that motorists also use other strategies to assist their navigational activities, e.g. wayfinding and route planning. In fact, the study clearly demonstrated that local drivers would employ more than one strategy in both tasks. This may imply the limitation of using one type of strategy. It is perhaps that by using more strategies, drivers would be able to reach their intended destinations.

- Another contribution made by this study was the identification of route choice criteria employed by the motorists in different types of trips.

This study documented several types of criteria used in route selection. Nevertheless, the study also found that there was some similarity regarding the usage of criteria in several different trips. In other words, drivers would also use the same criteria even though their journey purposes are different. In addition, the study also supported the literature which shows difficulties in arriving at universal conclusion about the relative importance of choice that drivers used in selecting a route for several journey purposes.

The study has provided some useful information regarding route choice criteria that drivers would use in selecting a route especially in Kuala Lumpur, Malaysia. This information could provide the responsible agencies such as Ministry of Transportation in assisting drivers' route choice selection process by presenting information in order for motorists to achieve their goal, e.g. selecting the best optimum routes based upon their needs and journey purposes. In addition, the results could assist system designers to create some sort of facilitators that could help motorists find the best route to their destination.

- This thesis also contributed to the research on content/structure of verbal mode of traffic information presentation.

It examined several issues such as drivers' response and reasons of their action regarding the traffic information that they would received. In addition, the thesis also investigated the important elements of traffic information which could be used in designing appropriate traffic information in order to present the information to the drivers. Furthermore, the study also provides some interesting findings regarding traffic information preferences. The information could help systems designers to consider the issue of reliability, credibility and accurateness of traffic messages to be given to the target users. In addition, the thesis also revealed the need to present variety of traffic messages (i.e. content of traffic messages) Thus, the study is important especially in Malaysia in order to develop a committed information systems which could present traffic information on congestion.

Related to the above issues, the final study (Study 3) may served as a pioneer to gain greater knowledge on drivers' response when giving several types of messages on congestion, e.g. warning, suggestion and other types of messages. In addition, the study also highlighted some of the elements that need to be considered by system designers when they actually develop the intelligent systems. As mentioned earlier, most of the benefits from the study may contribute to the enhancement knowledge especially regarding local drivers.

Finally, this section is concentrated on the contribution made by this study to the system designers in designing the so-called intelligent systems. Firstly, the study has presented several different types of information which could be useful for the use of drivers in several types of journey (as shown in Table 9.1). Thus, system designers should carefully consider on how best to present the information according to the diverse needs of drivers. In addition, the study also contributed to the knowledge of system designers concerning important elements that should be included in future traffic messages particularly messages on congestion. Drivers required more information rather than a just a single type of information. Thus, it is a challenge for system designers in order to design an appropriate information system for the use of its end users. The transformation process (as shown in Figure 9.1) could be used as sources of developing and presenting relevant information that are needed by drivers. It is hope that system designers could acknowledge and be aware of the diverse needs of their target users of the so-called intelligent systems.

In conclusion, although there are numbers of significant contribution made by this research, it is hope that other local studies could be done in order to enrich local researcher knowledge regarding the specific aims of this thesis. In addition, more research is needed to bring about some guidelines in developing Malaysian drivers information systems which should be based mainly on local drivers information requirement rather than focusing on others from countries such as Japan or U.S.

9.7. The way forward

Despite the usefulness of the methodology developed in this study to explore several interesting aims of this thesis and significant contribution made by the study, there appear to be some limitations. For example, it is not certain whether the method employed in this study truly represented or capable of eliciting the relevant information that are needed. Having to ask subjects to report their information needs may not be the appropriate procedure if it is not supplemented with other types of method such as simulation study or real life situation study. The studies in this thesis did not used several objective measures which could be useful in exploring and identifying other types of information that are relevant to the drivers. Thus, it would have been interesting to have had such measures, both on the road, in the laboratory or in other places. Such information might have allowed the identification of various types or division of information that could be explored in greater detail. They could allow the degree of agreement between the information to be required by drivers in different measures such as on the road and the simulated driving to be assessed. It would also have overcame some of the limitations in the identification and measurement of information required by drivers.

In addition, the results and discussions presented in this thesis have raised several additional research questions. The proposed research should consider the human factors issues before the so-called information systems goes into the developments and market for the use of its intended end users. For instance, the following lists represents some of the issues which need to be investigated further regarding drivers' information requirements and other issues related to it.

- Driving is a complex task that demands more study and the use of various kind of approaches in order to investigate drivers' information requirements.

- Drivers' information requirements should also cover not only commuters but also other types of motorists' population, e.g. dispatchers, commercial and other categories of drivers.

- Research on drivers' responses and performance when they actually received the information.

These three issues clearly stressed a need to investigate more thoroughly regarding motorists' information requirements for the development of the drivers' information systems. For example, past studies have enhanced our knowledge regarding the types of method or approach that were used to elicit drivers' information requirements. Nevertheless, the results based upon the past studies were enormous and should be treated with caution especially concerning the limited number of subjects participated in those studies. In addition, there is also limited information regarding other types of motorists' information requirements such as dispatchers, commercial and others. Not only were not represented in the body of knowledge regarding drivers' information requirements, they were also mistakenly identified as other type of motorists.

Apart from the above issue, the future study should include more real life situations e.g. based upon drivers performance and reaction when they actually use the intelligent systems inside or outside their vehicles. This kind of research perhaps could enhance our knowledge on what kind of information do drivers want, in what modality and when exactly they are needed.

- Future investigation on how much information do drivers need and how they could retain or assimilate this variety of information in their limited information processing capacity in order to make their decisions.

- Investigations of other types of journey, e.g. leisure or recreational, business trips and others. It is because different types of journey may prompt different kind of information.

- Furthermore, research on appropriate mode and timing to present the information should include both the objective and subjective measures.

It is because this knowledge could contribute to the appropriate timing of presenting the information to the drivers. The issues of timeliness of information presentation should be the main theme in developing drivers' information systems. These issues are also related to what kind of information do drivers need. Both techniques, e.g. objective and subjective methods should be used which could assist investigators in identifying and determining the suitable mode and timing of presenting the required information. The issue is related to the responses of users when they actually receive the information. Thus, future work should concentrate more into this kind of aspects.

- Future investigation on the various drivers groups is urgently required such as investigation on gender, driving experience and other demographic aspects.

It is interesting to have a study that concentrated on this issue. As evident in this thesis, male and female drivers do differ in their information requirements. In fact, there are also some differences between younger and older drivers on information requirements. Thus, by conducting more study on this issue alone, we could enhance our knowledge regarding users' differences on information requirements. In addition, we also have greater knowledge on the kind of information required by each gender.

- Further work on the design and use of navigational system is needed.

This thesis only investigated the strategies that drivers would make when making several unfamiliar journeys. The study has found that drivers on average would use four different types of strategies in order to arrive at their destination. Thus, future investigation should concentrate more on this aspect especially when designing the appropriate mode of navigational systems. Besides, future research is needed in studying how drivers performed with different set of strategies while making an unfamiliar journey. In addition, drivers navigation information requirements should be investigated, e.g. route planning and wayfinding. Several past studies show that in navigational activities alone, there are variety of information required (e.g. Burns, 1997; Burnet, 1988).

The study shows that using map was highly preferred compared to other types of navigation strategies. Human factor issues such as driver's performance when using maps and other types of strategies need to be addressed. In addition, drivers navigation issues also need to be investigated in several types of situation, e.g. simulation, road trial or real life experiments. The use of various kinds of experiments could provide different information that would enriched the knowledge regarding drivers' navigation problems and performance. Other human factor issues that need to be explored are what information do drivers need and how the information help them in influencing their decisions. This kind of study is not done in the present research.

- Related to the above issues, there is a need to study visual demands of navigation task by using a variety of method and environments, e.g. simulation or real-life.

- In addition, there is a need to investigate where do drivers look for information for navigation task.

- Furthermore, future study must also examine the timing of information to be present to drivers when making navigation task by using several modes to presenting the information.

All of the issue presented in the above should be listed in the future study. Although, there are wide ranging of studies that has been done relating to the three issues in the above, the data gathered were not sufficient in order to help system designers fully understood the problem. It is because the different nature or context of the investigation. Thus, as well as to enhance our knowledge, the future study should also serve to find out objectively these issue before developing the information systems. Several human factors issues that need to be included is drivers memory load and number of messages that need to be given to drivers.

- Future study on route choice criteria need to address issues such as drivers performance when employing variety of criteria in selecting route in several types of conditions, e.g. experiment vs real-life.

- In addition, there is also a need to investigate drivers prior knowledge on route choice criteria and decision process, e.g. how drivers choose routes.

- Furthermore, future study needs to examine other factors that would affect drivers' route choice behaviour, e.g. route attributes, personal and trips characteristics.

- Moreover, there is a need to address the issue of mental workload when giving an advice to drivers regarding their route choice criteria. Related to the earlier issues, future study needs to investigate drivers' behaviour or decision regarding compliance and acceptance of advice.

Although the present study contributed to the identification of criteria that drivers would employed while selecting a route for several different journey purposes, there is not enough information which could be used in developing the intelligent systems. For instance, there is a need to objectively investigate the drivers' route choice criteria in several different scenarios such as in laboratory or in real life situation. Besides, different scenarios would gather interesting information/data about the issues. The present study also did not examine other factors such as personal characteristics that may influence the selection of certain criteria in selecting a route to a particular destination.

The last issue could enhance system designers' apprehension regarding the advice given by the information system regarding the appropriate criteria in selecting a route. By studying future users compliance and acceptance of advice, system designers could carefully developed some sort of systems that may attract potential users rather than installed in the vehicle but users does not use the systems. It also could supply relevant information regarding which type of advice do drivers prefer or in other words, can drivers really trust the information given to them by an intelligent systems if they already have good knowledge about the route network. Previous study suggest that some drivers may not want to listen to the system if they knew the route network well enough (e.g. Kantowitz et al., 1997). Thus, it is important for any future study to resolve this matter. In fact, this issue also should be done especially when eliciting drivers' information requirements for several different types of journey.

Study 3 in this present thesis reported some of the interesting idea regarding the development of future traffic messages on congestion for system designers. However, more study is needed especially when the findings in this study cannot be applied equally for all the motorists in Malaysia and around the world. Thus, future investigations should consider:

- Drivers' response and reaction of their response when presented with traffic information by using verbal mode of information presentation.

- Future study should also consider other mode of traffic information presentation which could also influence driver's decision making. For example, different kinds of mode of information presentation may result in different kinds of response by the drivers.

- In addition, different type of important elements to be included in the information presented to the drivers should also be investigated.

It is because in this thesis there were some elements in the traffic message that could influence drivers' decisions. Therefore, there is a need to identify further several important elements that need to be presented to the drivers. In addition, variety of types of traffic messages that should be presented to the drivers' needs to be examined. For example, drivers' responses and performance when receiving different types/criteria/elements of traffic messages need to be studied before the actual traffic messages can be developed and presented to the drivers. Apart from the aforementioned issue, future investigation should cover elements such as:

- Investigation on a number of important elements that need to be given to drivers and the appropriate mode and timing of information presentation.

- Further study also must link the above issues with drivers' decision making process. For example, what made drivers decided to divert to alternative route when given, for example, travel time when using the suggested route.

- In addition, there is also a need to examine how drivers assimilate and retain the messages given to them (whether they were given visually or verbally or both of them) and the influence of the messages on their decision making ability and outcome of their decisions. This type of research could be done in both simulation and real life situations.

- Finally, there is an immediate need to investigate further drivers' preferences toward traffic messages which were presented by several different modes such as verbal, text or visual. In addition, other researchers also need to address the content, format and attributes of the information/messages that need to be presented to the drivers.

All of these issue have not been fully answered by this present study and previous work reported in the literature. Thus, there is an urgent need to answer all the questions set out in this thesis. In conclusion, the thesis provides some interesting points for future study to consider. In addition, there are a variety of human factors issues that are related to the issues of drivers' information requirements. Nevertheless, the thesis provided some highlights especially in the Malaysian context for developing drivers information systems. Therefore, the thesis could serve as the starting point for other future studies, e.g. in Malaysia, to investigate several other aspects regarding information requirements in order to develop drivers' information systems.

9.8. Thesis Conclusions

The study reported in this thesis has explored interesting objectives such as what kind of information do drivers need in several trip purposes. The variability of the information required by drivers in this study has supported several previous work by several investigators such as Spyridakis et al., (1991), Tsai (1991), Streff & Wallace (1993) and Penttinen et al (1996). Thus, it can be concluded that drivers required more than one type of information for different journey purposes. Indeed, the findings clearly demonstrated that different type of journey prompted different kinds of information. Therefore, it could be concluded that the nature of trips might influence the information requirements. For instance, when deciding to divert to alternative route, most of the subjects preferred to have advance information relating to the task that they faced, e.g. deciding whether to divert to alternate route. The study was also concerned with the criteria that drivers would use in selecting a route. The findings supported previous works that concluded the difficulty in arriving at universal conclusion regarding which kind of criteria were suitable in influencing drivers' in route selection. The result reported that a variety of criteria was used in selecting a route for different types of journey. Thus, it can be concluded that drivers need more than just one criterion in choosing a route to a particular destination. Nevertheless, the criteria used in selecting a route may also depend upon other factors such as workplace and individual characteristics.

A study concerning navigational related problem demonstrated that respondents would prefer maps in order to guide them in planning their unfamiliar trips and finding their way in unfamiliar environments. The most interesting findings offered by this study was the usage of more than one type of strategies by drivers in navigational activities, e.g. route planning and wayfinding. The results clearly indicated the need of drivers to obtain more information that they could use in achieving their target, i.e. to arrive at their intended destination. The experimental works done in this study also shows some interesting insights such as different types of traffic messages on congestion resulted in different kinds of drivers' responses and reasons of their responses. This also confirmed previous works that also found the same interpretation. In addition, several important elements in traffic messages such as time and distance may influence drivers' decision-making. Furthermore, drivers would like to have more information when given traffic messages on congestion. This may suggest the need to include more information rather than information which have a single value.

In general, this thesis found new evidents relating to the aims of the study. The important part of the study was for the system designers to contemplate the information gathered from this research. This study provides some interesting points for systems developers' to think about before designing the information systems. The possible solution is to develop advanced information systems which is based upon drivers' information requirement and needs. This advanced information system should store a wide range of information which suit drivers' needs and their journey purposes. It is because the users have diverse requirement and needs which need to be understood before developing the so-called intelligent system. In addition, the advanced systems must have variety of capabilities and function where drivers have the final say in making decision. Nevertheless, the systems might assist drivers if they are designed to meet the diverse needs of its end users.

The studies reported in this thesis have taken up several interesting ideas to think about. Based on the findings, drivers' information needs varied. The findings of this study provided at least a clear set of information which are needed for different set of journey purposes. In addition, it also provided some interesting evidents regarding the usage of criteria by drivers when selecting a route to a particular destination. It is also important to point out that drivers would use several types of strategies in navigational related problem, e.g. route planning and wayfinding. Finally, the future traffic messages on congestion could be designed better if they were targeted to the intended users rather than just to inform. With respect to the findings of this thesis, the variability of drivers information requirements should be acknowledge by all especially system designers and researchers before actually designing the so-called driver information systems.

References

Abdel-Aty, M., Kitamura, R. & Jovanis, P.P (1997). Using stated preference data for studying the effect of advanced traffic information on drivers' route choice. ***Transportation Research C***, Vol. 5, No. 1, pp. 39-50.

Abkowitz, M. (1981). An Analysis of the commuter departure time decision. ***Transportation***, Vol. 10, pp. 283-297.

Akamatsu, M., Yoshioka, M., Imacho, N., & Kawashima, H. (1994). Driving with a car navigation system: Analysis of landmarks by the thinking aloud method. In **International Ergonomics Association** 4 (pp. 148-150). Toronto: IEA.

Akerboom, S.P. (1989). The understanding and recollection of radio traffic information. Dissertation. Leiden. The Netherlands: Leiden University. As cited in Verwey, W.B. (1996). Evaluating safety effects of in-vehicle information systems (IVIS). ***TNO Report TM-96-C068***. Soesterberg, The Netherlands: Institute of Perception TNO.

Allen, T.M., Lunenfeld, H., & Alexander, G.J. (1968). Driver information needs. ***Highway Research Record 360*** (pp. 103-115). Washington, D.C: Highway Research Record Board.

Alm, H. & Nilsson, L. (1994). Changes in driver behaviour as a function of handsfree mobile phones- A simulator study. ***Accident Analysis & Prevention***, Vol. 26, pp. 441-451.

Alm, H., Nilsson, L., Järmark, S., Savelid, J. and Hennings, U. (1991). The effects of landmark presentation on driver performance and uncertainty in a navigation task- a field study, ***Swedish PROMETHEUS IT-4***, VTI, Linkoping, Sweden.

Alm, H. (1990). Driver's cognitive models of routes. In W. Van Winsum, H. Alm & J.M. Schraagen (eds.). ***Laboratory and field studies on route representation and drivers' cognitive models of routes***. Groningen: Traffic Research Centre.

Alm, H. (1993). Route navigation: Deciding driving information needs. In A.M. Parkes & S.Franzen (eds.). ***Driving future vehicles*** (pp. 187-192). London: Taylor & Francis.

Andersen, R., Kasper, J., & Frankel, M.R. (1979). ***Total survey error***. San Francisco: Jossey-Bass.

Antin, J.F., Dingus, T.A., Hulse, M.C., & Wierwille, W. (1990). An evaluation of the effectiveness and efficiency of an automobile moving-map navigational display. ***International Journal of Man-Machine Studies***, Vol. 33, pp. 581-594.

Antin, J.F. (1993). Informational aspects of car design: navigation. In Peacock, B. & Karwowski, W. (eds). ***Automotive Ergonomics*** (pp. 321-338). Washington, D.C : Taylor & Francis.

Armstrong, B.D. (1977). The need for route guidance. ***Transport Road Research Laboratory 330***, Crowthorne, United Kingdom.

Ashby, M.C., & Parkes, A.M. (1993). Interface design for navigation and guidance. In Parkes, A.M. & Franzen, S. (eds). ***Driving Future Vehicles*** (pp. 295-310). London : Taylor & Francis.

Ashby, M.C., Fairclough, S.H. & Parkes, A.M. (1991). A Comparison of two route information systems in an urban environment. ***DRIVE V1017 Report 49***, HUSAT Research Institute.

Astley, R.W. (1969). A Note on the requirements of road maps users. ***The Cartographic Journal***, Vol. 6, pp. 130.

Axhausen, K.W., Polak, J., Boltze, M., Puzicha, J. (1994). Effectiveness of the parking guidance information system in Frankfurt am Main. ***Traffic Engineering & Control***, May, pp. 304-309.

Aubrey, J.B. & Dobbs, A.R. (1990). Age and sex differences in mental realignment of maps. Experimental Aging Research, 16, pp. 133-139.

Babbie, E. (1992). ***The Practice of Social Research*** (6th ed.). Belmont, CA : Wadsworth Co.

Barfield, W., Haselkorn, M., Spyridakis, J., & Conquest, L. (1989). Commuter behaviour and decision making: Designing motorists information systems. In ***Proceedings of 33rd Annual Human Factors Society Conference*** (pp. 611-614), Human Factors Society, Santa Monica, CA.

Barfield, W., Haselkorn, M., Spyridakis, J., & Conquest, L. (1991). Integrating commuter information needs in the design of a motorists information systems. ***Transportation Research A***, Vol. 25A, No. 2/3, pp. 71-78.

Beck, R.J. & Wood, D. (1976). Cognitive transformation of information from urban geographic fields to mental maps. ***Environment and Behavior***, 8, pp. 199-238.

Ben-Akiva, M., Bergman, M.J., Daly, A.J., & Ramaswamy, R. (1984). Modelling inter-urban route choice behaviour. In ***Proceedings Ninth International Symposium on Transportation and Traffic Theory*** (pp. 299-330). Utrecht, Netherlands: VNU Science Press.

Ben-Akiva, M., dePalma, A., & Kaysi, I. (1991). Dynamic network models and driver information systems. ***Transportation Research A***, Vol. 25A, pp. 251-266.

Benshoof, J.A. (1970). Characteristics of route selection behaviour. ***Traffic Engineering & Control***, 11 (2), April 1970, pp. 604-606, 609.

Berge, G., Midtland, K., Kolias, V., & Papadoupolos, D., (1990). Driver information requirements, Oslo: DRIVE project V1024 Driver Information Systems, Interim Report I1-1 in ***Driving Future Vehicles*** (eds. A.M.Parkes & S.Franzen) pp.89-98. London: Taylor & Francis.

Berge, C. (1992). Special information needs among professional drivers. In A.M. Parkes & S. Franzen (eds.). ***Driving future vehicles***. (pp. 89-98). London: Taylor & Francis.

Bishu, R.R., Foster, B., & McCoy, P.T. (1991). Driving habits of the elderly; A survey. In ***Proceedings of 35th Annual Human Factors Society Conference*** (pp.1134-1138). Human Factors Society, Santa Monica, CA.

Black, J.A. & Champion, D.J. (1976). ***Methods and issues in social research***. New York: John Wiley & Sons.

Bonsall, P. (1992). The influence of route guidance advice in urban network. ***Transportation***, Vol. 19, pp. 1-23.

Bonsall, P., Pickup, L., & Stathopoulos, A. (1991). Measuring behavioral responses to road transport telematics. In ***Advanced Telematics in Road Transport*** (pp. 1457-1487). ***Proceeding of the DRIVE Conference***, Brussels, Feb. 4-6, 1991.

Bonsall, P. & May, A. (1986). Route choice in congested route networks. In Research for Tomorrows' Transport Requirements (pp. 1407-1425). ***Proceedings WCTR*** Vancouver : University of British Columbia Press.

Bourque, L.B., & Clark, V.A. (1992). ***Processing data: The survey example***. Newbury Park: Sage Publications.

Bovy, P.H.L., & Stern, E. (1990). ***Route choice: Wayfinding in transportation networks***. London: Kluwer.

Boyce, D.E. (1988). Route guidance systems for improving urban travel and location choices. ***Transportation Research A***, Vol. 22A, pp. 275-281.

Bradburn, N.M. (1983). Response effects. In P.H. Rossi, J.D. Wright, & A.B. Anderson (eds.). ***Handbook of Survey Research*** (pp. 289-328). New York: Academic Press.

Bradburn, N.M., & Sudman, S. (1979). ***Improving Interview Method and Questionnaire Design***. San Francisco: Jossey-Bass.

Brooks, L.R. (1968). Spatial and verbal components of the acts of recall. ***Canadian Journal of Psychology***, Vol. 22, pp. 349-368.

Bronzaft, A.L., Dobrow, S.B., & O'Hanlon, T.J. (1976). Spatial orientation in a subway system. ***Environment & Behavior***, Vol. 8, pp. 575-594.

Brown, I.D. (1986). Functional requirements of driving. As cited in Rumar, K. (1993). Road user needs. In A.M. Parkes & S. Franzen (eds.) ***Driving Future Vehicles.*** London: Taylor and Francis.

Brown, I.D., Tickner, A.H., & Simmonds, D.C.V. (1969). Interference between concurrent tasks of driving and telephoning. ***Journal of Applied Psychology***, Vol. 53, pp. 419-424.

Burnett, G.E., & Joyner, S.M. (1993). An investigation into man-machine interfaces of existing route guidance systems. In ***VNIS '93. Proceedings of the IEEE-IEE Vehicle Navigation and Information Systems Conference***, (pp. 395-400). IEEE, Ottawa, Canada, 12-15 October, 1993

Burnett, G.E., May, A., & Ross, T. (1994). The prediction of the effectiveness of landmarks for use within a route guidance system. ***HARDIE (DRIVE II Project V2008, Deliverable 15***). HUSAT.

Burnet, G.E. (1998). "Turn right at the King's Head" - Drivers' requirements for route guidance information. Unpublished Ph.D. Dissertation. Department of Human Sciences, Loughborough University.

Burns, P.C. (1997). Older driver and navigation systems. Unpublished Ph.D. Dissertation. Department of Human Sciences. Loughborough University.

Byrne, R. (1979). Memory for urban geography. ***Quarterly Journal of Experimental Psychology***, Vol. 31, pp. 147-154.

Caplice, C., & Mahmassani, H.S. (1992). Aspects of commuting behavior: Preferred arrival time, use of information and switching propensity, ***Transportation Research A***, Vol. 26A, No. 5, pp. 409-418.

Caubert, C., Pejoan, J.A., Adham, A., Nicolas, A. (1994). Basis of VMS road information language. In ***Proceedings of First World Congress on Applications of Transport Telematics and Intelligent Vehicle Highway Systems***, pp. 264-269. Paris

Chase, W.G., & Chi, M. (1980). Cognitive skill: Implications for spatial skill in large scale-environments. ***Technical Report No. 1***, Pittsburgh, PA: University of Pittsburgh, Learning and Development Centers.

City Hall. (1992). ***Kuala Lumpur: Traffic and congestion problem***. Kuala Lumpur: City Hall.

Colomb, M., & Hubert, R. (1991). Legibility and contrast requirements of Variable-Messages Signs. ***Transportation Research Record 1318***, pp. 137-141. Transportation Research Board, Washington, D.C.

Conquest, L., Spyridakis, J., Haselkorn, M., & Barfield, W. (1993). The effect of motorists information on commuter behavior: Classification of drivers into commuter groups. ***Transportation Research C***, Vol. 1, No. 2, pp. 183-201.

Craik, F.I.M. (1977). Age differences in human memory. In J.E. Birren & K.W. Schaie (eds.). ***Handbook of the psychology of aging*** (pp. 384-420). New York: Van Nostrand Reinhold.

Cross, K.D. & McGrath, J.J. (1977). A study of trip planning and map use by American motorists. ***Technical Report No. FHWA-WV-77-10***. Charleston, VA: West Virginia Department of Highways.

Daimon, T., Kawashima, H., & Akamatsu, M. (1997). Drivers' cognitive process and route guidance. In Y. Ian Noy (ed.). ***Ergonomics and safety of intelligent drivers interfaces***. Mahwah, N.J. : Lawrence Erlbaum.

Daniels, E., Levin, M., McDermott., T. (1976). Improving commercial radio reports in the Chicago area. ***Transportation Research Record 600***, pp. 52-57. Transportation Research Board, Washington, D.C.

Davis, J.R. (1989). The back seat driver: real time spoken driving instructions. In ***Proceedings of Vehicle Navigation and Information Systems***, VNIS'89, (pp. 146-150). Toronto: IEEE

Devlin, A.S. (1976). The "Small Town" cognitive map: Adjusting to a new environment. In G.T. Moore & R.G. Golledge (eds.). ***Environmental Knowing: Theories, Research and Methods*** (pp. 5866). Stroudsburg, PA: Dowden, Huchingson & Ross.

Devlin, A.S. & Bernstein, J. (1995). Interactive wayfinding: use of cues by men and women. ***Journal of Environmental Psychology***, 15, pp. 23-38.

Dewan Masyarakat (1992). ***Congestion in Kuala Lumpur***. Kuala Lumpur: Dewan Bahasa & Pustaka.

Dewar, R.E. (1988). In-vehicle information and driver workload. ***International Journal of Vehicle Design***, Vol. 9, No. 4/5, pp. 557-564.

Dingus, T.A., Hulse, M.C., Krage, M.K., Szczublewski, F.E, Berry, P. (1991). A usability evaluation of navigation and information systems "Pre-drive" functions. In ***Proceedings Vehicle Navigation and Information Systems Conference (VNIS '91)***, pp. 527-536. New York: IEEE-IEE.

Dingus, T.A. & Hulse, M.C. (1993). Some human factors design issues and recommendation for automotive navigation systems. ***Transportation Research C***, (2), pp. 119-131.

Dohrenwend, B.S. (1965). Some aspects of open and closed questions on respondents answers. ***Human Organization***, Vol. 24, pp. 175-184.

Dudek, C.L., Weaver, G.D., Hatcher, D.R., & Richards, S.H.(1978). Field evaluation of messages for real-time diversion of freeway traffic for special events. ***Transportation Research Record 682***, pp. 37-45. Transportation Research Board, Washington, D.C.

Dudek, C.L., Huchingson, R.D., & Brackett, R.Q. (1983). Studies of highway advisory radio messages for route diversion. ***Transportation Research Record 904***, pp. 4-9. Transportation Research Board, Washington, D.C.

Dudek, C.L., Messer, C.J., & Jones, H.B. (1971). Study of design consideration for real-time freeway information systems. ***Highway Research Record 363***, pp. 1-17. Highway Research Board, Washington, D.C.

Dudek, C.L., Stockton, W., & Hatcher, D. (1982). Real-time freeway to freeway diversion: The San Antonio experience. ***Transportation Research Record 841***, pp. 1-14, Transportation Research Board, Washington, D.C.

Dudek, C.L., Freibele, J., & Loutzenheise, R. (1971). Evaluation of commercial radio for real-time drivers communications for urban freeways. ***Highway Research Records 358***, pp. 17-25. Highway Research Board, Washington, D.C.

Duffell, J.R., & Carden, P.J. (1983). Car drivers route choice: A perception study of the 'rat-running' phenomenon at St. Albans, Herfordshire. ***Traffic Engineering & Control***, November, 1983, pp. 520-527.

Duffell, J., & Kalombaris, A. (1988). Empirical studies of car driver route choice in Herfordshire. ***Traffic Engineering & Control***, Vol. 29, No. 7/8.

Elliot, R.J., & Lesk, M.E. (1982). Route finding in street maps by computers and people. In ***Proceedings of the National Conference of the American Association for Artificial Intelligence*** (pp.258-261). University of Pittsburgh, PA.

Emmerink, R.H.M., Nijkamp, P., Rietveld, P., & Axhausen, K.W. (1994). The economics of motorists information systems revisited. ***Transport Reviews,*** Vol. 14, pp. 363-388.

Emmerink, R.H.M., Nijkamp, P., Rietveld, P., & Ommeren, J.N.V. (1996). Variable message signs and radio traffic information: An integrated empirical analysis of driver route choice behaviour. ***Transportation Research A***, Vol. 30, No. 2, pp. 135-153.

Engels, K., & Dellen, R.G. (1989). The effect of searching while driving on accident risks. Zeitschrift fur Verkehrssicherheir, 35, 3, pp. 93-100. As cited in Michon, J.A. (1993). ***Generic Intellingent Driver Support.*** (pp. 29). London: Taylor & Francis.

Fairclough, S.H., Ashby, M.C., Lorenz, K., & Parkes, A.M. (1991). A Comparison of route navigation and route guidance systems in an urban environment. In ***Proceedings of 24th ISATA International Symposium on Automobile Technology and Automation,*** Florence, Italy, 20-24th May, 1991, pp. 659-666.

Färber, B., Farber, Br.A., & Popp, M. (1986). Are oriented drivers better drivers? In ***Proceedings of 5th International Congress ATEC,*** "The lack of road safety", Vol. 7, pp. 1-9, Paris: ATEC.

Fern, E.F. (1982). The use of focus group for idea generation: The effects of group size, acquaintanceship and moderator on response quality and quality. ***Journal of Marketing Research,*** Vol. 19, pp. 1-13.

FHA (1992). ***1990 Nationwide Personal Transportation Study: Summary of Travel Trends.*** Office of Highway Information Management, Federal Highway Administration, Washington, D.C.

FHA (1992). ***Intelligent Vehicle-Highway System (IVHS) Project in the United States.*** Washington, D.C : IVHS America.

FHA (1984). Congestion problem in United States. As cited in Lindley, J.A. (1987). Urban freeway congestion : Quantification of the problem and effectiveness of potential solution. ***Journal of the Institute of Transportation Engineers,*** Vol. 57, pp. 27-32.

Frankfort-Nachmias, C., & Nachmias, D. (1992). ***Research Methods in the Social Sciences.*** London: Edward Arnold.

Freundschuh, S.M. (1991). The effect of the pattern of the environment on spatial knowledge acquisition. In D.M. Mark & A.U. Frank (eds.), ***Cognitive and Linguistic Aspects of Geographic Space*** (pp. 167-183). London: Kluwer.

Gale, N., Golledge, R.G., Pellegrino, J.W. & Doherty, S. (1990). The acquisition and integration of route knowledge in an unfamiliar neighbourhood. ***Journal of Environmental Psychology***, 10, pp. 3-25.

Galer, M.D. (1994). Driver vehicle interaction and human factors. In J.P. Pauwelussen, H.B. Pacejka (eds.). ***Smart Vehicles*** (pp. 381-387). Asmterdam: Swets & Zeitlinger.

Gatling, F.P. (1976). The effect of auditory and visual presentation of navigational messages on message retention. ***Report. No. FHWA-RD-76-94***. Washington, D.C, Federal Highway Administration, U.S. Department of Transportation.

Geehan, T.E., & Deslauriers, B.C. (1978). Transit route-guides: An investigation and analysis. ***Bus Ride***, Vol. 14 (4), pp. 56-58.

Golledge, R.G., Smith, T.R., Pellegrino, J.W., Marshall, S.P. & Doherty, S. (1985). A conceptual model and empirical analysis of children's acquisition of spatial knowledge. ***Journal of Environmental Psychology***, Vol. 5, pp. 125-152.

Gordon, D.A., & Wood, H.C. (1970). How drivers locate unfamiliar addresses: An experiment in route finding. ***Public Roads***, Vol. 36, pp. 44-47.

Graham, R., Mitchell, V.A., & Ashby, M.C. (1995). An analysis of drivers' requirements for motorway traffic information. In S.A. Robertson (ed.) ***Contemporary Ergonomics 1995***, (pp. 281-286). London: Taylor & Francis.

Graham, R., & Mitchell, V.A. (1997). An Evaluation of the ability of drivers to assimilate and retain in-vehicle traffic messages. In Y.Ian Noy (ed.). ***Ergonomics and Safety of Intelligent Driver Interfaces*** (185-202). Mahwah, New Jersey. Lawrencce Erlbaum.

Groeger, J.A., & Brown, I.D. (1989). Assessing one's own and others' driving ability: Influences of sex, age and experiences. ***Accident Analysis & Prevention***. Vol. 21, pp. 155-168.

Gould, M. D. (1989). Considering individual cognitive ability in the provision of usable navigation assistance. In ***Vehicle Navigation and Information Systems ' 89***, pp. 443-447. Toronto: IEEE.

Hall, R.W. (1983). Traveler route choice: Travel time implications of improved information and adaptive decisions. ***Transportation Research A***, Vol. 17A, No. 3, pp. 210-214.

Haselkorn, M., Spyridakis, J., Conquest, L., & Barfield, W. (1989). Surveying commuter behavior as a basis for designing motorists information systems. In ***Proceedings of 1st Vehicle Navigation and Information Systems Conference,*** Toronto, Canada: IEEE-IEE.

Hayward, H., Herbert, M., Hoffman, S., Parnall, S. & Still, P. (1994). Future opportunities for the provision and use of real-time dynamic traffic information services. ***Traffic Engineering & Control,*** November, pp. 608-610.

Heathington, K.W., Worrall, R.D., & Hoff, G.C. (1971). Attitudes and behavior of drivers regarding route driversion. ***Highway Research Record 363,*** pp. 18-26, Highway Research Board, Washington, D.C.

Huchingson, R., Whaley, J. & Huddelston, N. (1984). Delay messages and delay tolerance at Houston Work Zones. ***Transportation Research Record 957***, pp. 19-21. Transportation Research Board, Washington, D.C.

Huchingson, R., & Dudek, C.L. (1979). Delay time saved and travel time information for freeway traffic management. ***Transportation Research Record 722***, pp.36-39. Transportation Research Board, Washington, D.C.

Hyde, J.S. (1990). Meta-analysis and the psyhology of gender differences. ***Signs***, 16, pp. 55-73.

Hyman, H. (1954). ***Interviewing in Social Research***. Chicago: University of Chicago Press.

Ibrahim Wahab, (1991). ***City Transportation in Malaysia***. Kuala Lumpur: Dewan Bahasa & Pustaka.

Jackson, P. (1996). Group differences in ability to use verbal route guidance and navigation instructions. In S.A. Robertson (ed.). ***Contemporary Ergonomics 1996***, Leicester: Taylor & Francis.

Janssen, W.H. (1979). ***Routeplanning en geleiding: een literatuurstudie***, Soesterberg, The Netherlands: TNO Institute for Perception.

Janssen, W., & van der Horst, R. (1992). Presenting descriptive information in variable message signing. ***Transportation Research Record 1403***, pp. 83-87. Transportation Research Board, Washington, D.C.

Jeffery, D.J. (1981). Ways and means for improving driver route guidance. ***Transport Road Research Laboratory Report 1016***. TRRL, Crowthorne.

Jeffery, D.J. (1985). The potential benefits of route guidance. ***Transport Road Research Laboratory Report 997***, TRRL, Crowthorne.

Jeffery, D.J., Russam, K. (1984). Information systems for drivers. ***Transportation Planning & Technology***, Vol. 9, pp. 185-198.

Jeffery, D.J., Russam, K., & Robertson, D.I. (1987). Electronic route guidance by Autoguide: The research background. ***Traffic Engineering & Control***, Vol. 28.

Jovanis, P.P. & Kitamura, R. (1989). User perceptions and safety implications of in-vehicle navigation systems. In ***Procceding of Vehicle Navigation and Information Systems Conference VNIS '89*** (pp. 113-116). Ottawa, Canada: IEEE-IEE.

Kahn, R.L. & Cannell, C.F. (1957). ***The Dynamics of Interviewing***. New York: John Wiley & Sons.

Kaplan, R. (1976). Wayfinding in the natural environment. In G.T. Moore and R.G. Golledge (eds.). ***Environmental Knowing: Theories, Research and Methods*** (pp. 46-57). Stroudsburg, PA : Dowden, Huchingson & Ross.

Kantowitz, B.H., Hanoswki, R.J. & Kantowitz, S.C. (1997). Driver reliability requirements for traffic advisory information (pp. 1-23). In Y. Ian Noy,. (ed.). ***Ergonomics and Safety of Intelligent Driver Interfaces***. Mahwah, N.J. : Lawrence Erlbaum.

Katteler, H. (1995). Acceptance and impacts of RDS-TMC traffic information. Result of the ATT cross-project collaborative study. *Cord (DRIVE V2056) Deliverable AC16*. As cited in Verwey, W.B. (1996). Evaluating safety effects of in-vehicle information systems (IVIS). ***TNO Report TM-96-C086***. Soesterberg, The Netherlands: TNO Human Factors Research Institute.

Khattak, A., Schoffer, J., & Koppelmman, F. (1993). Commuter's en route diversion and return decisions: Analysis and implications for advanced traveler information systems. ***Transportation Research A***, Vol. 27A, pp. 101-111.

Khattak.A., Schofer, J. & Koppelman, F. (1991). Factors influencing commuters' en route diversion behavior in response to delay. ***Transportation Research Record 1318***, pp. 125-136. Transportation Research Board, Washington, D.C.

Kimura. K., Maranuaka, K., & Suguira, S. (1994). Human factors consideration for automotive navigation systems. In ***Proceedings of the 12th Trennial Congress of the International Ergonomics Association***, Toronto, 15-19 August, Vol. 4, Ergonomics and Design, pp. 162-165.

Kimura, K., Maranuaka, K. & Suguira, S. (1997). Human factor consideration for automotive navigation systems - Legibility comprehension and voice guidance. In Y. Ian Noy (ed.). ***Ergonomics and safety of intelligent drivers interfaces*** (pp. 153-167). Mahwah, N.J. : Lawrence Erlabum.

King, G.F. (1986). Drivers performance in highway navigation tasks. ***Transportation Research Record 1093,*** pp. 1-10. Transportation Research Board, Washington, D.C.

King, G.F., & Mast, T.M. (1987). Excess travel: Causes, extent and consequences. ***Transportation Research Record 1111,*** pp. 126-134. Transportation Research Board, Washington, D.C.

Kirasic, K.C. & Mathes, E.A. (1990). Effects of different means for conveying environmental information on elderly adults' spatial cognition and behaviour. ***Environment & Behaviour,*** Vol. 22, pp. 591-607.

Kishi, K. & Suguira, S. (1993). ***Human factor consideration for voice route guidance*** (SAE Paper 930553). Dearborn, MI: Society of Automotive Engineer.

Kitchin, R.M. (1994). Cognitive maps: What are they and why study them? ***Journal of Environmental Psychology***, Vol. 14, pp. 1-19.

Krueger, R.A. (1988). ***Focus groups***. Newbury Park, CA : Sage

Kuipers, B. (1978). Modelling spatial knowledge. ***Cognitive Science***, Vol. 2, pp. 129-153.

Lajunen, T., Hakkarainen, P., & Summala, H. (1996). The ergonomics of road signs and embedded speed limits. ***Ergonomics***, Vol. 39, pp. 1069-1083.

Lansdown, T.C. (1996). Visual demand and the introduction of advanced driver information system into road vehicle. Unpublished Ph.D. Dissertation. Department of Human Science. Loughborough University.

Leiser, R. (1993). Driver-vehicle interface: Dialogue design for voice input. In A.M. Parkes & S.Franzen (eds.). ***Driving Future Vehicle*** (pp. 275-294). London: Taylor & Francis.

Liable, G. (1989). Influence of in-car navigation maps display on drivers performance. ***SAE Paper No. 891683***. Society of Automotive Engineer, Warrendale, PA.

Liable, G. (1990). In-car road information: comparison of auditory and visual presentations. In ***Proceedings of the Human Factors Society 34th Annual Meeting*** (pp. 623-627). Santa Monica, CA: Human Factors Society, Inc.

Lindley, J.A. (1989). Urban freeway congestion and solution: An update. ***ITS Journal,*** Vol. 59, No. 12, pp. 21-23.

Lynch, K. (1960). **The image of the city**. London: M.I.T. Press.

Mahmassani, H.S. & Jayakrishnan, R. (1991). System performance and user response under real-time information in a congested traffic corridor. ***Transportation Research A***, Vol. 25A, pp. 293-301.

Mahmassani, H.S. & Chen-Te, P.S. (1993). An investigation of the reliability of real time information for route choice decisions in a congested traffic system. ***Transportation***, Vol. 20, pp.157-178.

Mahmassani, H.S., & Herman, R. (1984). Dynamic user equilibrium departure time and route choice on idealized traffic arterials. ***Transportation Science***, Vol. 18, pp. 362-384.

Mannering, F., Kim, S., Ng, L. & Barfield, W. (1995). Travelers preferences for in-vehicle information systems: An exploratory analysis. ***Transportation Research C,*** Vol. 3, pp. 339-351.

Mark, D.W., & McGranaghan, M. (1988). Map use and map alternatives. An experiment in interurban navigation. ***The Canadian Geographer,*** Vol. 32, pp. 69-75.

McCann, C. (1982). Classification of map-reading tasks. ***DCIEM Report No. 82-R-59.*** Defence and Civil Institute of Environmental Medicine.

McDonald, M., & Lyons, D. (1996). Driver information. ***Traffic Engineering & Control,*** January, 1996, pp. 10-15.

McRuer, D.T., Allen, R.W., Weir, D.H. & Klein, R.H. (1977). New result in driving steering control models. ***Human Factors***, Vol. 19, pp. 381-397.

Michon, J.A. (1985). A critical review of driver behavior models. In L. Evans & R.S. Schwing (eds.). **Human Behaviour and Traffic Safety** (pp. 487-525). New York: Plenum Press.

Miller, G.A. (1956). The magical number seven, plus and minus two: Some limits on our capacity for processing information. ***Psychological Review,*** Vol. 63, pp. 81-97.

Moray, N. (1981). The role of attention in the detection of errors and the diagnosis of errors in man-machine systems. In J. Rasmussen & W. Rouse (eds.) ***Human detection and diagnosis of failure.*** New York: Plenum Press.

Moser, C.A., & Kalton, G. (1971). ***Survey methods in social investigation*** (2nd ed.) London: Heinemann.

Moskowitz, K. (1956). California method of assigning diverted traffic to proposed freeways. ***Highway Research Bulletin N130,*** pp. 1-26, Highway Research Board, Washington, D.C.

Mourant, R.R., Rockwell, T.H., & Rackoff, N.J. (1970). Driver eye movement and visual workload. ***Highway Research Record 292,*** pp. 1-10. Highway Research Board, Washington, D.C.

Muller, P. (1989). Verkehrs (un) sicherheit-eine-collage zu anlass und zielen der veranstaltung. Dortmund: ILS Taschenbucker. In A.M. Parkes & S. Franzen (eds.). ***Driving future vehicles*** (pp. 7-16). London: Taylor & Francis.

Näätänen, R., & Summala, H. (1976). Expectancy and the related aspects of the estimation and judgement of the road user. In ***Road User Behaviour & Traffic Accidents*** (pp. 155-186). Amsterdam: North Holland.

Ng, L., Wessel, R.L., Do, D., Mannering, F., & Barfield, W. (1995). Statistical analysis of commercial drivers and dispatcher requirement for advanced traveler information systems. ***Transportation Research C,*** Vol. 3, No. 6, pp. 353-369.

Ng, L. & Barfield, W. (1997). Determining user requirements for intelligent transportation systems design. In Barfield, W., & Dingus, T.A. (eds). ***Human Factors in Intelligent Transportation Systems*** (pp. 325-357). Mahwah, NJ: Lawrence Erlbaum.

Noland, R.B. (1997). Commuter response to travel time uncertainty under congested conditions: Expected costs and the provision of information. ***Journal of Urban Economics,*** Vol. 41, pp. 377-406.

Noy, Y.I (1989). Intelligent route guidance: Will the new horse be as good as the old. In ***Proceedings of Vehicle Navigation and Information Systems (VNIS '89).*** IEEE-IEE, Toronto, Canada, pp. 49-55.

Noy, Y. & Zaidel, D. (1991). Methodological framework for evaluating the ergonomics of Advanced Driver Information Systems. In ***Proccedings of the 11th Congress of the International Ergonomics Associations,*** Paris, France.

Obata, T., Daimon, T., Kawashima, H. (1993). A cognitive study of in-vehicle navigation systems: Applying verbal protocol analysis in usability evaluation. In ***Proceedings of Vehicle Navigation and Information Systems (VNIS '93).*** IEEE-IEE, Ottawa, Canada, pp. 232-237.

Oppenheim, A.N. (1992). ***Questionnaire design, interviewing and attitude measurement.*** London: Printer Publishers Ltd.

Owens, D.A., Helmers, G. & Sivak, M. (1993). Intelligent vehicle highway systems: A call for user centered design. ***Ergonomics***, Vol. 36, pp. 363-369.

Parkes, A.M. (1991). The effects of driving and handfree telephone use on conversation structure and style. In ***Proceedings of the 24th Conference of the Human Factors Association of Canada***, Vancouver, Canada - 1991.

Parkes, A.M. & Burnett, G.E. (1993). An Evaluation of medium range advance information in route guidance display for use in vehicles. In ***Proceedings of the IEEE-IEE Vehicle Navigation and Information System Conference*** (pp. 238-241), Pisctaway, NJ: IEEE.

Passini, R. (1981). Wayfinding: A conceptual framework. ***Urban Ecology,*** Vol. 5, pp. 17-31.

Pauzie, A., & Anadon, S. (1993). Visual requirements of vehicle guidance systems: Approach focusing on elderly visual capacities. In B. Bouman & J.A.M. Graafmans (eds.). ***Gerontology : Studies in health technology and informatics*** (pp. 329-334). Oxford: IOS press.

Pauzie, A., & Marin-Lamellet, C. (1989). Analysis of aging drivers behaviors navigating with in-vehicle visual display systems. In ***Proceeding of the First Vehicle Navigation and Information Systems*** (pp. 61-67), Toronto, Canada: IEEE-IEE.

Penttinen, M., Louma, J., & Rama, P. (1997). Finnish drivers; information needs. Finnish National Road Administration. ***FinnRA Report 73/1996.*** Helsinki.

Polak, J.W., Hilton, I.C., Axhausen. K.W., Young, W. (1990). Parking guidance and information systems: Performance and capability. ***Traffic Engineering & Control,*** Vol. 31 (10), pp. 519-524.

Rasmussen, J. (1987). Reasons, causes and human error. In J. Rasmussen, K. Duncan, & J. Leplat (eds.) ***New technology and human error*** (pp. 293-301). Chichester; John Wiley & Sons.

Richards, S.H., Stockton, W.R., & Dudek, C.L. (1978). Analysis of driver responses to point diversion for special events. ***Transportation Research Record 682***, pp. 45-52. Transportation Research Board, Washington, D.C.

Riesbeck, C.K. (1980). "You can't miss it" : Judging the clarity of directions. ***Cognitive Science,*** Vol. 4, pp. 285-303.

Road Transport Departments. (1994). ***Selangor and Kuala Lumpur facts.*** Kuala Lumpur: RTD.

Robb, M.C. (1987). Route information systems for motorists. ***Transport Reviews***, Vol. 7, No. 3, pp. 259-275.

Rockwell, T.H. (1972). Skills, judgment and information acquisition in driving. In T.W. Forbes (eds.). ***Human factors in highway traffic safety research.*** New York: Wiley Interscience.

Rosenthal, R. & Rosnow, R.L. (1991). ***Essential of behavioral sciences: Methods and data analysis.*** Singapore : McGraw-Hill.

Ross, T., Vaughan, G. & Nicolle, C. (1997). Design guidelines for route guidance systems: Development process and an empirical example for timing of guidance instruction. In Y. Ian Noy (ed.). ***Ergonomics and safety of intelligent drivers interfaces*** (pp. 139-152). Mahwah, NJ: Lawrence Erlbaum.

Rosnow, R.L. (1968). A 'spread effect' in attitude formation. In A.G. Greewald, T.C. Brock, & T.M. Ostrom, (eds.) ***Psychological foundations of attitudes*** (pp. 89-107). New York : Academic Press.

Rothe, P.J., Cooper, P.J. & de Vries, B. (1990). Driving habits of the elderly: A survey. In ***Proceedings of 35th Human Factor Society Annual Meeting*** (pp. 1134-1138). San Francisco, CA : Human Factor Society.

Rothengatter, T., Alm, H., Kuiken, M.J., Michon, J.A. & Verwey, W.B. (1993). The driver. In J.A. Michon (ed.). ***Generic Intelligent Driver Support.*** London: Taylor & Francis.

Rumar, K. (1988). In-vehicle information systems. ***International Journal of Vehicle Design***, Vol. 9, pt 4-5, pp. 548-556.

Schlegel, R.E. (1983). Driver mental workload. In B. Peacock & Karwowski, W. (eds.). ***Automotive Ergonomics*** (pp. 359-382). Washington, D.C.: Taylor & Francis.

Schofer, J., Khattak, A., & Koppelman, F. (1993). Behavioral issues in the design and evaluation of advanced traveler information systems. ***Transportation Research C***, Vol. 1, No. 2, pp.107-117.

Schopert, D.W., Moskowitz, K. Hulbert, S.F. & Burg, A. (1960). Some principles of freeways directional signing based in motorists' experiences. ***Highway Research Bulletin N244***, pp. 30-87, Highway Research Board, Washington, D.C.

Schraagen, J,M.C (1989). Navigation in unfamiliar city: A review of literature and theoretical framework. ***Report IZF 1989-36.*** Soesterberg, The Netherlands : TNO Institute of Perception.

Schraagen, J.M.C. (1990). Use of different types of map of information for route following in unfamiliar cities. In CEC DRIVE I Project V1041, Deliverable GIDS/NAV2, pp. 49-66. As cited in Scraagen J.M.C. (1993). Information presentation in in-car navigation systems (pp. 171-186). In ***Driving Future Vehicles***. A.M. Parkes, & S.Franzen (eds.). London: Taylor & Francis.

Schraagen, J.M.C. (1993). Information presentation in in-car navigation systems. In A.M. Parkes & S.Franzen (eds.). ***Driving Future Vehicles*** (pp.171-186). London: Taylor & Francis.

Shaughnessy, J.J. & Zehmeister, E.B. (1990). ***Research methods in psychology***. New York: McGraw-Hill.

Sheffi, J., Mahmassani, H., & Powell, B.W. (1982). A transportation network evaluation model. ***Transportation Research A***, 16, pp. 209-218.

Sheppard, D., & Adams, J.M. (1971). A survey of drivers' opinion on maps for route finding. ***The Cartographic Journal***, Vol. 8, pp. 105-114.

Shinar, D. (1978). ***Psychology on the road: The human factor in traffic safety***. New York: Wiley.

Shirazi, E., Anderson, S. & Stesney, J. (1988). Commuters' attitudes toward traffic information systems and route diversion. ***Transportation Research Record 1168***. Transportation Research Board, Washington, D.C.

Simon, S.L., Walsh, D.A., Degnier, V.A., & Krauss, I.K. (1992). Spatial cognition and neighbourhood use: The relationship in older adults. ***Psychology and Aging***, 7, pp. 389-394.

Smith, T.R., Pellegrino, J.W., & Golledge, R.G. (1982). Computational process of spatial cognition and behaviour. ***Geographical Analysis***, Vol. 14, pp. 305-325.

Spoerri, A. (1993). Novel route guidance display. In ***Proceedings of Vehicle Navigation and Information Systems Conference VNIS '93***, pp. 410-422. Ottawa, Canada : IEEE-IEE.

Spyridakis, J., Barfield, W., Conquest, L., Haselkorn, M., & Isakson, C. (1991). Surveying commuter behavior: Designing motorist information systems. ***Transportation Research A***, Vol. 25A, No. 1, pp. 17-30.

Srinivasan, R. (1997). Effects of selected in-vehicle route guidance systems on drivers reaction times. ***Human Factors***, Vol. 39 (2), pp. 200-215.

Srinivasan, R., & Jovanis, P.P. (1997). Effect of in-vehicle route guidance systems on driver workload and choice of vehicle speed : Finding from a driving simulator experiments. In Y. Ian Noy (ed.) ***Ergonomics and safety of intelligent driver interfaces***. Mahwah, NJ: Lawrence Erlbaum.

Stamatiadis, N. (1993). Older drivers and IVHS technologies. In ***Advanced Transport Telematics/Intelligent Vehicle Highway Systems - Toward Development and Implementation***, 1 (pp. 381-388). Aachen, Germany: Automotive Automation Limited.

Stern, E., & Leiser, D. (1989). A Cognitive utility model for urban route choice. Report submitted to the Israel Academy of Science, Beer Sheva, As cited in Bovy, P.H.L. & Stern, E. (1990). ***Route choice : Wayfinding in transport network***. Doedrecht: Kluwer.

Stern, E., & Leiser, D. (1988). Levels of spatial knowledge and urban travel modelling. ***Geographical Analysis***, Vol. 20, No. 2, pp. 140-155

Stern, E. (1988). The behavioral approach in geography and its use in urban travel research. **Horizons in Geography**, 23, pp. 89-112.

Stevens, A., & Coupe, P. (1978). Distortions in judged spatial relations. ***Cognitive Psychology***, Vol. 10, pp. 422-437.

Stewart, D.W., & Shamdasani, P.N. (1990). ***Focus group: Theory and practice.*** Newbury Park; Sage Publications.

Stokes, A, Wickens, C., & Kite, K. (1990). ***Display technology: Human Factor aspects.*** Warrendale, PA: Society of Automotive Engineer.

Streeter, L.A., Vitello, D., & Wonsiewicz, S.A. (1985). How to tell people where to go: Comparing navigational aids. ***International Journal of Man-Machine Studies***, Vol. 22, pp. 549-462.

Streff, F.M. & Wallace, R.R. (1993). Analysis of drivers' information preferences and use in automobile travel: Implications for advanced traveller information systems. In ***Proceedings of Vehicle Navigation and Information Systems Conference, VNIS '93***, (pp. 414-148). Ottawa, Canada : IEEE-IEE.

Sudman, S., & Bradburn, N.M. (1974). ***Response effects in surveys: A review and synthesis***. Chicago: Aldine Press.

Thorndyke, P.W., & Hayes-Roth, B. (1982). Differences in spatial knowledge acquired from maps and navigation. ***Cognitive Psychology***, Vol. 13, pp. 407-433.

Transport Road Laboratory. (1994). ***Traffic and Transport***. TRL: Crowthorne.

Trueblood, D.C. (1952). Effects of travel time and distance on freeway usage. ***Public Roads***, Vol. 26, pp. 241-250.

Trinca, G., Johnston, I., Campbell, B., Haight, F., Knight, P., Mackay, G., McLean, A., & Petrucelli, E. (1988). ***Reducing traffic injury - A global challenge.*** Melbourne, Australia: A.H. Massina.

Tsai, J. (1991). Highway environment information system interest and features survey. In ***1991 Vehicle Navigation and Information System Conference***, pp. 113-122, Warrendale, PA:SAE.

Ulrich, S.R. (1974). Scenery and the shopping trip: The roadside environment as a factor in route choice. ***Michigan Geographical Publication 12***, University of Michigan, Ann Arbor, MI

Van Vugt, M., Van Lange, P.A.M. & Meertens, R.M. (1996). Commuting by car or public transportation? A social dilemma analysis of travel mode judgements. ***European Journal of Social Psychology***, Vol. 26, pp. 373-395.

Van Vuren, T. & Jansen, G.R.M. (1986). De verkeersafwikkeling van het containerwegvervoer van en naar de Rotterdamse haven. Stichting voor mobilities - en Transportresearch, Rapport 86.1, Delft. As cited in Bovy, P.H.L. & Stern, E. (1990). ***Route choice: Wayfinding in transport network.*** Doedrecht: Kluwer.

Van Winsum, W. (1989). ***Route choice criteria of car drivers: A review of literature.*** Traffic Research Centre: University of Gronigen.

Van Winsum, W. (1993). Selection of routes in routes navigation systems. In ***Driving Future Vehicles.*** A.M. Parkes, & S.Franzen, (eds.) pp. 193-203. London: Taylor & Francis.

Van Winsum, W. (1987). De mentale be lasting van hut navigeren in het verkeer, (No. VK 87-30) Rapport Verkeerskunding Studiecentrum. As cited in Schraagen, J.M.C. (1993). Information presentation in in-car navigation systems. In A.M. Parkes & S. Franzen (eds.). ***Drivng Future Vehicles*** (pp. 171-186). London : Taylor & Francis.

Vaugh, K., Abdel-Aty, M., Kitamura, R., Jovanis, P. & Yang, H. (1992). Experimental analysis and modeling of sequential route choice behaviour under ATS in a simplistic traffic network. ***Research Report No. UCD-ITS-RR-92-16.*** Davis, CA. University of California, Davis, Institute of Transportation Studies.

Verwey, W.B., & Janssen, W.H. (1988). *Route following and driving performance with in-car guidance systems.* ***Report IZF C-14.*** Soesterberg, The Netherlands: Institute of Perception TNO.

Verwey, W.B. (1996). *Evaluating safety effects of in-vehicle information systems (IVIS). TNO Report TM96-C068*. Soesterberg, The Netherlands: TNO Institute of Human Factors Institute.

Verwey, W.B., Alm. H., Groeger, J.A., Janssen, W.H., Kuiken, M.J., Schraagen, J.M.C., van Winsum, W., & Wontorra, H. (1993). GIDS function. In ***Generic Intelligent Driver Support: A Comprehensive Report on GIDS***. Michon, J.A. (ed.), pp. 113-144. London: Taylor & Francis.

Verwey, W.B., Brookhuis, K.A., & Janssen, W.H. (1996). *Safety effects of in-vehicle information systems. **TNO Report TM-96-C002***. Soesterberg, The Netherlands: TNO Human Factors Research Institute.

Wachs, M. (1967). Relationships between drivers' attitudes toward alternate routes and drivers and route characteristics. ***Highway Research Record 197***, pp. 70-87. Highway Research Board, Washington, D.C.

Wallace, R.R. & Streff, F.M. (1993). Developing advanced traveler information systems: Considering drivers' information needs. ***UMTRI Research Review***, May-June 1993. Vol. 23, Pt. 6, pp. 1-13.

Wenger, M.J., Spyridakis, J.H., Haselkorn, M.P., Barfield, W., & Conquest, L. (1989). Motorists behavior and the design of motorist information systems. ***Transportation Research Record 1281***, pp. 159-167. Transportation Research Board, Washington, D.C.

Whitfield, J.W. (1950). As indicated in C.A.Moser & G.Kalton (1993). ***Survey methods in social investigation*** (pp. 346). Aldershot: Dartmouth Press.

Wickens, C.D. (1990). ***Engineering Psychology and Human Performance*** (2nd ed.). London : Harper Collins.

Wickens, C.D. (1984). Processing resources in attention. In Parasuraman, R., & Davies, D.R. (eds.). ***Varieties of attention***. Orlando, FL: Academic Press.

Wierwille, W.W, Antin, J.F., Dingus, T.A., & Hulse, M.C. (1988). Visual attentional demand of an in-car navigation display system. In A.G. Gale et al. (eds.). ***Vision in Vehicles II***, pp. 307-316. Amsterdam : North Holland.

Wierwille, W.W, Hulse, M.C., Fischer, T.J., Dingus, T.A. (1990). Visual adaptation of the driver to high-demand driving situations while navigating with an in-car navigation systems. In Gale, A.G. et al. (eds.). ***Vision in vehicles III***, Amsterdam: North Holland.

Wierwille, W.W. (1993). Demands of drivers resources associated with introducing advanced technology into the vehicle. ***Transportation Research C,*** 1, pp. 133-142.

Williamson, J. & Barrow, C. (1994). Errors in everyday routefinding: A classification of types and possible causes. ***Applied Cognitive Psychology***, Vol. 28, pp. 513-514.

Williamson, J.B., Karp, D.A., Dalphin, J.R., & Gray, P.S. (1982). ***The research craft: An Introduction to social research methods*** (2nd ed.) Boston : Little & Brown Co.

Williamson, J. & McGuiness, C. (1990). The role of schemata in the comprehension of maps. In. K.J. Gihooly, M.T.G. Keane, R.H. Logie, & G. Erdos (eds.). ***Lines of Thinking***. London: John Wiley & Sons.

Wotton, J., Ness, M., & Burton, R.S., (1981). Improved direction signs and the benefits of road users. ***Traffic Engineering and Control***, Vol. 22, pp.264-268.

Zaidel, D.M. (1991). Specification of a methodology for investigating the human factors of advanced driver information systems. ***Technical Report TP 11199 (E)***. Ottawa, Canada: Road Safety and Motor vehicle regulation, Transport Canada.

Appendix 1

Discussion Schedule

Introduction

Thank participants

The purpose of this discussion to explore drivers knowledge regarding new technologies in vehicle, information requirements and most important experience toward congestion.

The discussion is being recorded so that I can transcribe it later. All your comments will remains anonymous. Please stop when I said it is the time to stop discussion. We may break half way through. Do you have any questions?

Discussion Points

- Self-introductions
  Name
  Working details
  Driving experiences

- Describe your commuting trips
  When you choose your route to and from work?
  Did you know other route that you could take to their destination?.

- Experience and opinion toward congestion

- New Technology and information requirements
  Did you know about new technology in vehicles?
  What kind of information do you think you need while commuting to and from work?

Conclusion

Is there anything else about the above topic that you would like to share that we have not yet touched upon. Thank participants.

Appendix 2

Exploratory Interview Schedule

Exploratory Interview Schedule

This interview aims to explore driver's knowledge on several issues, for example congestion and new technologies in vehicle. All the answers given will be treated in strict confidential. Thank you.

1.Gender

2.Ethnic

3.Driving Experiences

4. Working details
    4a. starting work time
    4b. finish work time

5.Types of employment

6. Experience when involve with congestion

7.Did you know about new technology in vehicle

8.Sources of your knowledge regarding new technology in vehicle

9.What are the information that your think you require?

Thank you for your participants.

Appendix 3

Preliminary Postal Survey

Postal Survey

The survey asks your about drivers information requirements. The information you provide will contribute toward the designing of Drivers Information Systems for cities drivers. Your answer will be treated in strict **CONFIDENCE**.

Instructions for answering the questionnaires

1. There are 3 sections in this questionnaire;
   Section A : Demographics Aspects and Commuting Details
   Section B : Congestion Information (home-work)
   Section C : Congestion Information (work - home)

2. Answer each question by placing / in the appropriate box or fill in the space with your own answer.

3. Please complete all questions. Thank you.

Section A : Demographics Aspects and Commuting Details

1. Your age class
   - ☐ 20-29 years old
   - ☐ 30-39 years old
   - ☐ 40-49 years old
   - ☐ 50-59 years old

2. Ethnic group
   - ☐ Malay
   - ☐ Chinese
   - ☐ Indian
   - ☐ Others

3. Gender
   - ☐ Male
   - ☐ Female

4. What is your occupation (Please specify)

....

5. What is your occupational types?

- ☐ Private sectors
- ☐ Government sectors
- ☐ Self-own
- ☐ Others (Please specifiy)

6. Your level of income per month?

- ☐ Below $500
- ☐ Between $501-$1000
- ☐ Between $1001-2000
- ☐ More than $2000

7. Where do you live?

☐ Kuala Lumpur (Please specify the areas)

....

☐ Outside Kuala Lumpur (Please specify the areas)

....

8. Where is your workplace (Please specify the areas)

....

....

9. What time do you usually start work?

- ☐ Before to 8.00 a.m.
- ☐ Between 8.00 - 8.30 a.m.
- ☐ Between 8.30-9.00 a.m.
- ☐ After 9.00 a.m.

10. What time do you usually finish your work and go home?

- ☐ Before to 4.15 p.m.
- ☐ Between 4.15 - 5.00 a.m.
- ☐ Between 5.00-5.30 a.m.
- ☐ After 5.30 a.m.

11. Estimate the distance between your home and workplace

- ☐ less than 5 km
- ☐ 6 - 10 km
- ☐ 11 - 15 km
- ☐ more than 15 km

12. Estimate the time taken from your home to workplace

☐ less than 15 mins ☐ 16 to 30 mins

☐ 31 to 45 mins ☐ more than 45 mins

13. Estimate the time taken from your workplace to home

☐ less than 15 mins ☐ 16 to 30 mins

☐ 31 to 45 mins ☐ more than 45 mins

Section B : Congestion Information (home-work)

This sections asks you regarding information that drivers think useful in helping them in dealing with congestion while on the way to work.

1.In your opinion,what kind of information do you think you need in order to deal withcongestion?(Pleasespecify)

....

....

2. Method to present the information that you required in dealing with congestion?

☐ Commercial radio ☐ CB radio

☐ In-vehicle systems ☐ Variable Messages Signs (VMS)

☐ Others (Please specify) ....

3. When do you think that the information should be presented to drivers?

☐ Before the trips ☐ Both (e.g. before and during the trips)

☐ During the trips ☐ Others(Please specify) ....

Section C : Congestion Information (Work - home)

This sections asks you regarding information that drivers think useful in helping them in dealing with congestion while on the way to home.

1. In your opinion,what kind of information do you think you need in order to deal with congestion? (Please specify)

   ....

   ....

2.Method to present the information that you required in dealing with congestion?

☐ Commercial radio ☐ CB radio

☐ In-vehicle systems ☐ Variable Messages Signs (VMS)

☐ Others (Please specify) ....

3. When do you think that the information should be presented to drivers?

☐ Before the trips ☐ Both (e.g. before and during the trips)

☐ During the trips ☐ Others(Please specify) ....

THANK YOU FOR TAKING TIME TO CONTRIBUTE TO THIS SURVEY

Appendix 4

Preliminary Interview Survey

Motorists Information Needs Study

Section A : Details about commuters

1. Do you drive to work?
   - ❑ Yes
   - ❑ No

2. Your age group?
   - ❑ Less than 20 years old
   - ❑ 20-29 years old
   - ❑ 30-39 years old
   - ❑ 40-49 years old
   - ❑ 50-59 years old
   - ❑ above 60 years old

3. Your ethnic group?
   - ❑ Malay
   - ❑ Chinese
   - ❑ Indian
   - ❑ Others (please specify) ....

4. Gender?
   - ❑ Male
   - ❑ Female

5. Who employs you?
   - ❑ Private company
   - ❑ Government department
   - ❑ Self-employed
   - ❑ Others (please specify)____________

6. What is the highest level of educational you have attained?
   - ❑ Primary school
   - ❑ Secondary school
   - ❑ Colleges
   - ❑ University

7. How long have you been driving regularly?
   - ❑ less than 1 year
   - ❑ 1-5 years
   - ❑ 6-10 years
   - ❑ more than 10 years

8. Place of resident?
   - ❑ in K.L.
   - ❑ outside K.L

Section B : About your working details and commuting trips

1. What time do you usually start work?
   - ☐ 7.45 a.m.
   - ☐ 8.00 -8.30 a.m
   - ☐ 8.30-9.00 a.m.
   - ☐ after 9.00 a.m.

2. What time do you usually finish your work and go home?
   - ☐ 4.15 p.m.
   - ☐ 5.00 -5.30 p.m
   - ☐ 5.30-6.00 p.m.
   - ☐ after 6.00 a.m.

3. How long have you worked at your job in its present location?
   - ☐ 1-2 years
   - ☐ 3-5 years
   - ☐ 6-10 years
   - ☐ more than 10 years

4. How far is it between your home and your workplace?
   - ☐ 1-5 km
   - ☐ 6-10 km
   - ☐ 11-15 km
   - ☐ more than 15 km

5. How long does it take to travel from home to work?
   - ☐ 5-15 mins
   - ☐ 16-25 mins
   - ☐ 26-35 mins
   - ☐ 36 45 mins
   - ☐ more than 45 mins

6. How long does it take to travel from work to home?
   - ☐ 5-15 mins
   - ☐ 16-25 mins
   - ☐ 26-35 mins
   - ☐ 36-45 mins
   - ☐ more than 45 mins

7. When do you chose what route to take?

- ☐ before getting to the car
- ☐ once in the car
- ☐ both (before and once)

8. Do you know about any route you could take to work, other than the one you usually take?

- ☐ Yes
- ☐ No

9. How many alternate route do you usually use regularly?

- ☐ none
- ☐ 1 route
- ☐ 2 routes
- ☐ 3 routes
- ☐ 4 or more routes

10. Have you ever used any of these routes?

- ☐ Yes
- ☐ No

11. Have you ever changes routes to another highway or street, while you are on your way to your work?

- ☐ Yes
- ☐ No

12. Have your ever changes routes to another highway or street, while you are on your way to your home?

- ☐ Yes
- ☐ No

13. When are you likely to change route?

- ☐ journey from home to work
- ☐ journey from work to home

Section C : Driver Information Needs

I. The following section asks you questions about what kinds of information do you need while commuting from your home to workplace.

Below is a list of information that some drivers have stated they would find useful while commuting from home to workplace. Please indicate which information, if any, you think you would find useful while commuting to your workplace.

1= Congestion information
2= Accident detection information
3= Weather information
4= Vehicle status
5= Route guidance/navigation
6= Alternative route recommendations
7= Trip planning
8= Parking services information
9= Others (Please state in the column provides)

Fill in one or more numbers corresponding to the above options and/or give other information that you think you would find useful in this situation (e.g. Needs.....7,).

1. What kind of information do you think you would find useful while commuting from home to work?

   Needs ....:
   Others (Please state)...:

2. When would you like the information to be presented?

   ☐ before the trip ☐ both (before and during the trip)
   ☐ during the trip

3. How would you like the information to be presented?

   ☐ CB radio (e.g. taxis) ☐ Commercial radio (e.g. Time Highway)
   ☐ Variable Message Signs ☐ In-vehicle information systems

II. The following section asks you questions about what kinds of information you need while commuting from your workplace to your home.

Below is a list of information that some drivers stated they would find useful while commuting from their workplace to their home. Please indicate which information, if any, you think you would needs while commuting to your house.

1= Congestion information
2= Accident detection information
3= Weather information
4= Vehicle status
5= Road condition
6= Route guidance/navigation
7= Alternative route recommendation
8= Trip planning
9= Parking services
10= Others (Please state in the column provides)

Fill in one or more numbers corresponding to the above options and/or give any other information that you think you would find useful in this situation (e.g. Needs..2, 5.).

1. What kind of information do you think you would find useful while commuting from workplace to home?

   Needs...:
   Others..:

2. When would you like the information to be presented?

   ☐ before the trip　　☐ both (before and during the trip)
   ☐ during the trip

3. How would you like the information to be presented?

   ☐ CB radio (e.f. taxis)　　☐ Commercial radio (e.g. Time Highway)
   ☐ Variable Message Signs　　☐ In-vehicle information systems

III. The following section asks you questions about what kind of information you think you need when making a journey/driving through an unfamiliar areas/environment. An unfamiliar environment/areas is somewhere you have never been before.

1. Have you ever driven to an unfamiliar area/destination?

   ☐ Yes (If Yes, answer Q2-Q5)   ☐ No (If No, answer Q6-Q9)

Below is a list of information that some people stated while driving into an aread that was unfamiliar to them. Please indicate what information, if any, you would find useful while making a journey in an unfamiliar areas/environments.

1 = Road condition information
2 = Route finding information
3 = Traffic information
4 = Alternative route information
5 = Route following information
6 = Parking services
7 = Trip planning
8 = Others (Please state in the column provides)

Fill in one or more numbers corresponding to the above options and.or give any other information that you think you would find useful in this situation (e.g.,..1, 7.).

2. Based upon your own experience driving to an unfamiliar destination, what kinds of information do you think, you would find useful for making unfamiliar trips>

   Needs ....:
   Others...:

3. When would you like the information to be presented?

   ☐ before the trip   ☐ during the trip

   ☐ both (before and during the trip)

4. How would you like the information to be presented?
   - ❑ CB radio (e.g. taxis) ❑ Commercial radio (e.g. Time Highway)
   - ❑ Variable Message Signs ❑ In-vehicle information systems

5. How did you plan your last trip to an unfamiliar destination?
   - ❑ consulted a road atlas
   - ❑ had an acquaintance plan the route
   - ❑ went without planning
   - ❑ made notes of the route
   - ❑ made a sketch map of the route
   - ❑ contacted a motoring organisation (e.g. AAM)
   - ❑ asked someone for the route information
   - ❑ others (Please state)..

Imagine that you are driving to unfamiliar area for the first time (e.g. City, town, or urban areas). In your opinion, what kinds of information would you find useful when driving to your destination which are unfamiliar to you?

Below is a list of information that some people stated while driving into an areas that was unfamilar to them. Please indicate what kind information, if any, you would find useful while making a journey in an unfamiliar areas.

1 = Road condition
2 = Route finding
3 = Traffic information
4 = Alternative route
5 = Route following
6 = Parking services
7 = Trip planning
8 = Others (Please state in the column provides)

Fill in one or more numbers corresponding to the above options and/or give any other information that you think you would find useful in this situation (e.g. Needs 3, 5...).

6. In your opinion, what kind of information do you think useful in helping you while making an unfamiliar trips?

   Needs...:
   Others..:

7. When would you like the information to be presented?

   ☐ before the trip　　☐ both (before and during the trips)

   ☐ during the trip

8. How would you like the information to be presented?

   ☐ CB radio (e.g. taxis)　　☐ Commercial radio (e.g. Time Highway)

   ☐ Variable Message Signs　　☐ In-vehicle information systems

9. How would you plan the route to your unfamiliar destination?

   ☐ consulted a road atlas/map
   ☐ had an acquaintance plan the route
   ☐ went without planning
   ☐ made notes of the route
   ☐ made a sketch map of the route
   ☐ contacted a motoring organisation (e.g. AAM)
   ☐ asked someone for the route information
   ☐ Others (Please state)..

Thank you for your cooperation
All information will be treated in <u>strict confidence</u>

Appendix 5

Interview Survey

Driver Information Requirement Study

General Information

Subject No ☐☐☐☐

Area of selection

- ☐ K.L. City Centre
- ☐ Gombak/Ampang/D.Keramat
- ☐ P.J/S.J/S.Alam
- ☐ Kajang/BBB/Serdang
- ☐ Cheras/Sg.Besi
- ☐ Damansara/Kepong

1. Do you own a car?

- ☐ Yes
- ☐ No

2. Do you drive to and from work?

- ☐ Yes
- ☐ No

3. How often you drive to and from work?

- ☐ always
- ☐ more than once a week
- ☐ less than once a week
- ☐ most days
- ☐ once a week
- ☐ never

4. Do you ...

- ☐ live and work in K.L.
- ☐ live and work outside K.L.
- ☐ live in K.L. but work outside K.L.
- ☐ live outside K.L. but work in K.L.
- ☐ others (Please state) ______________________________

Driving Experience

1. How old were you when you first got your driver's licence?

   ________ years old

2. For how many years have you held a full driving licence?

   ________ years old

3. For how many years have you driven regularly?

   ________ years old

4. On average, how many days of the week do you drive?

   ________ days

Working Details

1. What time do you usually start work?

   ❑ before 8.00 a.m. ❑ 8.00 – 8.30 a.m.
   ❑ 8.30 – 8.30 ❑ after 9.00 a.m

2. How far is it between your home and your workplace?

   ❑ 1 to 5 km ❑ 6 to 10 km
   ❑ 11 to 15 km ❑ more than 15 km

3. How long does it take to travel from home to work (in average weekdays)?

   ❑ less than 15 mins ❑ 16 to 25 mins
   ❑ 26 to 35 mins ❑ 36 to 45 mins
   ❑ more than 45 mins

4. Do you home straight from work?

- ❑ Yes
- ❑ No

5. What time do you usually finish your work and go home?

- ❑ before 4.00 p.m.
- ❑ 4.15 p.m.
- ❑ 4.16-5.00 p.m.
- ❑ after 5.00 p.m.

6. How long does it take to travel from work to home (in average weekdays)?

- ❑ less than 15 mins
- ❑ 16 to 25 mins
- ❑ 26 to 35 mins
- ❑ 36 to 45 mins
- ❑ more than 45 mins

7. How much flexibility is there in time when you ...

	A lot	Some	Very little
leave home to go to work	❑	❑	❑
arrive at work	❑	❑	❑
leave work to home	❑	❑	❑
arrive at home	❑	❑	❑

Commuting Trips

1. When do you choose what route to take (e.g. to work and from work)?

- ❑ before getting into the car
- ❑ once in the car
- ❑ both (before and once)
- ❑ en-route to destination
- ❑ always take the same route
- ❑ others (Please state) ________________

2. Do you know (about) any routes you could take to work or home, other than the one you usually take?

- ❑ Yes *(answer Q3a-3b)*
- ❑ No *(answer Q3c)*

3a. How many alternative routes do you know which you could take to or from work?

- ☐ 1 route
- ☐ 2 routes
- ☐ 3 routes
- ☐ 4 or more routes

3b. Have you ever used any of these routes?

- ☐ Yes *(answer Q4a)*
- ☐ No *(answer Q4b)*

3c. Please give the reason of why you don't know any routes that you could take to work or home, other than the one you usually take?

- ☐ I don't know any other or alternative route
- ☐ There is simply no other routes or alternative routes
- ☐ I don't want to change my driving habits
- ☐ others (Please state) ______________________________

4a. What was the main reason, why you used the alternative route last time?

....

....

Advantages of using the alternative routes

....

....

Disadvantages of using the alternative routes

....

....

4b. What are the main reasons, why you don't use the alternative routes?

....

....

Advantages of not using the alternative routes

....

....

Disadvantages of not using the alternative routes

....

....

5. During your commute to and from work, how much importance do you place on...

	A lot	Some	Very little
saving commuting time	❑	❑	❑
reducing commuting distance	❑	❑	❑
increasing commuting safety	❑	❑	❑
increasing commuting enjoyment	❑	❑	❑

6. Are you willing to change routes while commuting?

❑ Yes *(answer Q7-Q9)*　　❑ No *(answer Q10)*

7. Yes, I would change the routes while commuting, **IF** ...

❑ There are alternative routes
❑ I knew in advance about congestion
❑ I knew about alternative route
❑ I knew the alternative routes saves my time
❑ others (Please state) ______________________

8. When are you most likely to take alternative or change route while commuting?

❑ journey from home to workplace
❑ journey from workplace to home
❑ both (to and from home)

9. What would help/make you decide to change route while commuting?
....
....

10. Why you would not change or take alternative route while commuting?
....
....

Commuting Trips Information Requirement

The following section asks question about traffic information requirements for commuting trips. Based upon your experience, what kinds of traffic information, do you think you or other drivers' require/needs for **HOME TO WORK COMMUTING TRIPS.**

1. Please ticked the information that you needs based upon the importance of types of traffic information that you need while on your way from home to work. Rank the important of information (from 1st important to 5th important) and indicate the timing to present the information.

Information Requirement for Home to Work Trips

Types of Traffic Information	Before driving	While driving
☐ congestion information	☐	☐
☐ incident detection	☐	☐
☐ weather information	☐	☐
☐ vehicle status	☐	☐
☐ road condition	☐	☐
☐ route guidance	☐	☐
☐ alternative route recommendation	☐	☐
☐ trip planning	☐	☐
☐ parking information	☐	☐
☐ traffic state prediction	☐	☐
☐ route selection	☐	☐
☐ traffic condition	☐	☐
☐ roadside services	☐	☐
☐ rules and regulations	☐	☐
☐ roadwork or maintenance	☐	☐
Others (Please state)		
☐	☐	☐
☐	☐	☐

2. Based upon your experience, what kinds of traffic information, do you think you or other drivers' require/needs for **WORK TO HOME COMMUTING TRIPS.**

Please tick the information that you needs based upon the importance of types of traffic information that you need while on your way from work to home. Rank the important of information (from 1st important to 5th important) and indicate the timing to present the information.

Information Requirement for Work to Home Trips

Types of Traffic Information	Before driving	While driving
☐ congestion information	☐	☐
☐ incident detection	☐	☐
☐ weather information	☐	☐
☐ vehicle status	☐	☐
☐ road condition	☐	☐
☐ route guidance	☐	☐
☐ alternative route recommendation	☐	☐
☐ trip planning	☐	☐
☐ parking information	☐	☐
☐ traffic state prediction	☐	☐
☐ route selection	☐	☐
☐ traffic condition	☐	☐
☐ roadside services	☐	☐
☐ rules and regulations	☐	☐
☐ roadwork or maintenance	☐	☐
Others (Please state)		
☐	☐	☐
☐	☐	☐

3. Did you receive any traffic information?

☐ Yes *(If Yes, answer Q3a-Q4)*

☐ No *(If No, answer Q4)*

3a. From which medium, did you receive traffic information?

	Time to present information			
	Home-work		Work-home	
Medium (select one only)	Pre-trip	En-route	Pre-trip	En-route
CB radio		☐		☐
Commercial radio	☐	☐	☐	☐
Variable Message Signs		☐		☐
Television	☐		☐	
Mobile Phone	☐	☐	☐	☐
Advisory radio (RDS-TMC)		☐		☐
In-vehicle information system	☐	☐	☐	☐

4. From which medium, would you prefer to receive traffic information?

	Time to present information			
	Home-work		Work-home	
Medium (select one only)	Pre-trip	En-route	Pre-trip	En-route
CB radio		☐		☐
Commercial radio	☐	☐	☐	☐
Variable Message Signs		☐		☐
Television	☐		☐	
Mobile Phone	☐	☐	☐	☐
Advisory radio (RDS-TMC)		☐		☐
In-vehicle information system	☐	☐	☐	☐
Others (Please state) ☐	☐	☐	☐	☐

Congestion Information Requirements

1. Have you experienced any en-route delay, congestion or traffic jams longer than 10 minutes while you were on your way to or from work during the past six (6) months?

❑ Yes ❑ No *(Go to Q8)*

2. How long ago did this [delay, congestion] happen?

❑ less than 1 month ❑ 1-2 months
❑ 2-3 months ❑ 3-4 months
❑ more than 4 months ❑ Don't know

3. How much time did expect the "delay or congestion" to add to your trip?

❑ 10-20 minutes ❑ 21- 30 minutes
❑ 31-40 minutes ❑ 41-50 minutes
❑ more than 50 months ❑ Don't know

4. How did you get the information on the "delay or congestion"?

❑ radio traffic report on congestion ahead
❑ own observation of unusual heavy congestion
❑ other drivers alerted
❑ other (Please state) ______________________

5. What did you do after getting the information on the "delay" on your usual route?

❑ Yes *(answer Q6)* ❑ No *(answer Q7)*

6. What were the advantages of taking alternative routes?

....
....
....

7. What are the advantages of continuing on your usual route?

....
....
....

8. Based upon your driving experience, what kind of information do you think that you or other drivers require in dealing with congestion.

Please tick the information that you need based upon the importance of types of traffic information that you need in order to deal with congestion while you are on your way from **Home to Workplace**. Rank the important of information (from 1st important to 5th important) and indicate the timing to present the information.

Congestion Information Requirement
From Home to Workplace

Types of Traffic Information	Before driving	While driving
☐ congestion information	☐	☐
☐ weather information	☐	☐
☐ route guidance	☐	☐
☐ alternative route recommendation	☐	☐
☐ speed of vehicles	☐	☐
☐ traffic state prediction	☐	☐
☐ route selection	☐	☐
☐ condition of congestion	☐	☐
☐ traffic volume	☐	☐
☐ length of congestion	☐	☐
☐ location of congestion	☐	☐
Others (Please state)		
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐

9. Based upon your driving experience, what kind of information do you think that you or other drivers require in dealing with congestion.

Please tick the information that you need based upon the importance of types of traffic information that you need in order to deal with congestion while you are on tour way from **Workplace to Home**. Rank the important of information (from 1st important to 5th important) and indicate the timing to present the information.

Congestion Information Requirement
From Workplace to Home

Types of Traffic Information	Before driving	While driving
☐ congestion information	☐	☐
☐ weather information	☐	☐
☐ route guidance	☐	☐
☐ alternative route recommendation	☐	☐
☐ speed of vehicles	☐	☐
☐ traffic state prediction	☐	☐
☐ route selection	☐	☐
☐ condition of congestion	☐	☐
☐ traffic volume	☐	☐
☐ length of congestion	☐	☐
☐ location of congestion	☐	☐
Others (Please state)		
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐

10. Did you receive any traffic information (e.g., congestion information)?

☐ Yes *(If Yes, answer Q10a-Q11)* ☐ No *(If No, answer Q11)*

10a. From which medium, did you receive traffic information (e.g., congestion information)?

	Time to present information			
	Home-work		Work-home	
Medium (select one only)	Pre-trip	En-route	Pre-trip	En-route
CB radio		☐		☐
Commercial radio	☐	☐	☐	☐
Variable Message Signs		☐		☐
Television	☐		☐	
Mobile Phone	☐	☐	☐	☐
Advisory radio (RDS-TMC)		☐		☐
In-vehicle information system	☐	☐	☐	☐

11. From which medium, would you prefer to receive traffic information (e.g., congestion information)?

	Time to present information			
	Home-work		Work-home	
Medium (select one only)	Pre-trip	En-route	Pre-trip	En-route
CB radio		☐		☐
Commercial radio	☐	☐	☐	☐
Variable Message Signs		☐		☐
Television	☐		☐	
Mobile Phone	☐	☐	☐	☐
Advisory radio (RDS-TMC)		☐		☐
In-vehicle information system	☐	☐	☐	☐
Others (Please state) ☐	☐	☐	☐	☐

Alternative Route Information Requirement

The following section asks question about traffic information, drivers require when deciding to divert to alternative route when their regular routes are congested. Based upon your experience, what kinds of traffic information, do you think you or other drivers' require/needs in advance, in order to make decision to divert to alternative route while making trip from your **HOME TO WORKPLACE.**

1. Please tick the information that you need based upon the importance of types of traffic information that you need in order to decide when to divert to alternative route while you are on tour way from **Home to workplace.** Rank the important of information (from 1st important to 5th important) and indicate the timing to present the information.

Alternative Route Information Requirement
From Home to Workplace Trips

Types of Traffic Information	Before driving	While driving
☐ congestion on usual route	☐	☐
☐ condition of alternative route	☐	☐
☐ difference in travel time between routes	☐	☐
☐ traffic volume on alternative route	☐	☐
☐ driving time on alternative route	☐	☐
☐ ease of access to alternative route	☐	☐
☐ location of alternative route	☐	☐
☐ familiarity with alternative route	☐	☐
☐ number of cars taking alternative route	☐	☐
☐ level of congestion on original route	☐	☐
☐ similarity of original and alternative route	☐	☐
☐ traffic prediction on alternative route	☐	☐
☐ length of alternative route	☐	☐
Others (Please state)		
☐	☐	☐
☐	☐	☐

2. Please tick the information that you need based upon the importance of types of traffic information that you need in order to decide when to divert to alternative route while you are on tour way from **Workplace to Home.** Rank the important of information (from 1st important to 5th important) and indicate the timing to present the information.

Alternative Route Information Requirement
From Workplace to Home Trips

Types of Traffic Information	Before driving	While driving
❑ congestion on usual route	❑	❑
❑ condition of alternative route	❑	❑
❑ difference in travel time between routes	❑	❑
❑ traffic volume on alternative route	❑	❑
❑ driving time on alternative route	❑	❑
❑ ease of access to alternative route	❑	❑
❑ location of alternative route	❑	❑
❑ familiarity with alternative route	❑	❑
❑ number of cars taking alternative route	❑	❑
❑ level of congestion on original route	❑	❑
❑ similarity of original and alternative route	❑	❑
❑ traffic prediction on alternative route	❑	❑
❑ length of alternative route	❑	❑
Others (Please state)		
❑	❑	❑
❑	❑	❑

3. Did you receive any traffic information (e.g., alternative route information)?

❑ Yes *(If Yes, answer Q3a-Q4)*

❑ No *(If No, answer Q4)*

3a. From which medium, did you receive traffic information (e.g., alternative route information)?

	Time to present information			
	Home-work		Work-home	
Medium (select one only)	Pre-trip	En-route	Pre-trip	En-route
CB radio		☐		☐
Commercial radio	☐	☐	☐	☐
Variable Message Signs		☐		☐
Television	☐		☐	
Mobile Phone	☐	☐	☐	☐
Advisory radio (RDS-TMC)		☐		☐
In-vehicle information system	☐	☐	☐	☐

4. From which medium, did you receive traffic information (e.g., alternative route information)?

	Time to present information			
	Home-work		Work-home	
Medium (select one only)	Pre-trip	En-route	Pre-trip	En-route
CB radio		☐		☐
Commercial radio	☐	☐	☐	☐
Variable Message Signs		☐		☐
Television	☐		☐	
Mobile Phone	☐	☐	☐	☐
Advisory radio (RDS-TMC)		☐		☐
In-vehicle information system	☐	☐	☐	☐
Others (Please state) ☐	☐	☐	☐	☐

Unfamiliar Trips Information Requirements

The following section asks questions about what kinds of traffic information, drivers require when making an unfamiliar journey (e.g., unfamiliar routes, places or city). The unfamiliar journey is one in which you need some advice or information before setting off and/or during the journey.

1. Have you ever make an unfamiliar journey (e.g. unfamiliar routes, places, town or city)?

   ☐ Yes *(If Yes, answer Q2 & Q4)* ☐ No *(If No, answer Q3 & Q4)*

2. Based upon your experience, what kinds of traffic information that you think, you or other drivers require when making Unfamiliar Journey/Trips. Rank the important information (from 1st important to 5th important) and indicate the timing to present the information.

Information Requirement for Unfamiliar Trips

Types of Traffic Information	Before driving	While driving
☐ congestion information	☐	☐
☐ incident detection	☐	☐
☐ weather information	☐	☐
☐ vehicle status	☐	☐
☐ road condition	☐	☐
☐ route guidance	☐	☐
☐ alternative route recommendation	☐	☐
☐ parking information	☐	☐
☐ traffic condition	☐	☐
☐ roadside services	☐	☐
☐ tourists information	☐	☐
Others (Please state)		
☐	☐	☐

3. Imagine you are about to set off on an unfamiliar journey – remember an unfamiliar journey is one in which you need some advice/information before setting off and/or during the journey. In your opinions, what kinds of traffic information that you think, you or other drivers require when making Unfamiliar Journey/Trips. Rank the important information (from 1st important to 5th important) and indicate the timing to present the information.

Information Requirement for Unfamiliar Trips

Types of Traffic Information	Before driving	While driving
☐ congestion information	☐	☐
☐ incident detection	☐	☐
☐ weather information	☐	☐
☐ vehicle status	☐	☐
☐ road condition	☐	☐
☐ route guidance	☐	☐
☐ alternative route recommendation	☐	☐
☐ parking information	☐	☐
☐ traffic condition	☐	☐
☐ roadside services	☐	☐
☐ rules and regulations	☐	☐
Others (Please state)		
☐	☐	☐

4. Did you receive any traffic information (e.g., unfamiliar trips information)?

☐ Yes *(If Yes, answer Q4a-Q5)*

☐ No *(If No, answer Q5)*

4a. From which medium, did you receive traffic information (e.g., unfamiliar trips information)?

	Time to present information			
Medium (select one only)	Pre-trip	En-route	Pre-trip	En-route
CB radio		☐		☐
Commercial radio	☐	☐	☐	☐
Variable Message Signs		☐		☐
Television	☐		☐	
Mobile Phone	☐	☐	☐	☐
Advisory radio (RDS-TMC)		☐		☐
In-vehicle information system	☐	☐	☐	☐

5. From which medium, did you receive traffic information (e.g., unfamiliar trips information)?

	Time to present information			
Medium (select one only)	Pre-trip	En-route	Pre-trip	En-route
CB radio		☐		☐
Commercial radio	☐	☐	☐	☐
Variable Message Signs		☐		☐
Television	☐		☐	
Mobile Phone	☐	☐	☐	☐
Advisory radio (RDS-TMC)		☐		☐
In-vehicle information system	☐	☐	☐	☐
Others (Please state) ☐	☐	☐	☐	☐

Driver Route Choice Criteria

1. The following section asks about the drivers' route choice criteria for several different journey purposes. These route choice criteria/factors influence drivers decision to select/choose certain route in different trips. Based upon your experiences, please rank the factors/criteria according to how important it is to you when making commuting trips (home to work and work to home). Please rank them as below:

1 = Very Important
2 = Important
3 = Don't Know
4 = Not Very Important
5 = Not At All Important

	Journey Purposes	
Factors affecting choices of routes	To Work	From Work
1. Saving mileage	☐	☐
2. Saving time	☐	☐
3. Certainty of arrival time	☐	☐
4. Least complicated route	☐	☐
5. Safety	☐	☐
6. Avoiding congested route	☐	☐
7. Fastest route	☐	☐
8. Fewest stops	☐	☐
9. Convenience/accessible	☐	☐
10. Less traffic	☐	☐
11. Good traffic flows	☐	☐
12. Others (Please state)		
....	☐	☐
....	☐	☐

2. The following section asks about the drivers' route choice criteria for several different journey purposes. These route choice criteria/factors influence drivers decision to select/choose certain route in different trips. Based upon your experiences, please rank the factors/criteria according to how important it is to you when making unfamiliar trips. Please rank them as below:

1 = Very Important
2 = Important
3 = Don't Know
4 = Not Very Important
5 = Not At All Important

Factors affecting choices of routes	Journey Purposes Unfamiliar Trips
1. Saving mileage	☐
2. Saving time	☐
3. Certainty of arrival time	☐
4. Least complicated route	☐
5. Safety	☐
6. Avoiding congested route	☐
7. Fastest route	☐
8. Fewest stops	☐
9. Convenience/accessible	☐
10. Less traffic	☐
11. Good traffic flows	☐
12. Most relaxing routes	☐
13. Good scenery	☐
14. Others (Please state)	
....	☐
....	☐

Planning Unfamiliar Journey

The following section asks you questions about how you plan your routes. Planning refers to the preparations you make before driving on an unfamiliar journey. For example, planning may involve looking at a map or asking a friend for directions. This planning could occur before you get into your car or at some point along the route.

Below is a list of strategies (A-H), that some people use to plan their routes. Please indicate which strategy, if any, you would use in planning your unfamiliar journey. You may use one of the following strategies, more than one, or none at all.

A = Consult a road atlas/map
B = Look at city map
C = Had an acquaintance plan the route
D = Went without planning
E = Make notes of the route
F = Make a sketch map of the route
G = Contact a motoring organisation (e.g. AAM)
H = Ask someone for the route information
I = Others (Please state in the column provides)

Fill in one or more letters corresponding to the A-H options above and/or give another strategy that you use or would use in this situation (e.g., strategy....D, G....)

1. How would you plan your trip to an unfamiliar city?
   Strategies ....:
   Other (Please state) ....:

2. How would you plan your trip to an unfamiliar highway?
   Strategies ....:
   Other (Please state) ....:

3. How would you plan your trip on an unfamiliar routes?
   Strategies ....:
   Other (Please state) ....:

Finding Your Way While Driving

The following section asks you questions about how to find your way while driving. In this section, we are interested in strategies that drivers used in order to find their way while driving to unfamiliar trips/destination. While driving means when you are en-route to your destination (e.g. while the car is in motion or when you stop at a lay-by).

Below is a list of strategies (A-G) that some people used to find their way while driving. Please indicate which strategy, if any, you would use in each situation. You may use one of the following strategies, more than one, or none at all.

A = Read a sketch of the route
B = Read a road atlas/map
C = Read a street map
D = Read route notes
E = Rely on your memory from studying the route earlier
F = Stop and ask someone for directions
G =Try and find your way without help (i.e. by trial and error)
H =Others (Please state in the column provides)

Fill in one or more letters corresponding to the A-H options above and/or give another strategy that you use or would use in this situation (e.g., strategy....D, G....)

1. How would you find your way when making a trip to an unfamiliar city?
   Strategies ....:
   Other (Please state) ....:

2. How would you find your way on an unfamiliar highway?
   Strategies ....:
   Other (Please state) ....:

3. How would you find your way on an unfamiliar routes?
   Strategies ....:
   Other (Please state) ....:

Some Details About Yourself

1. How old are you? ____________ years old

2. What is your ethnic group?

- ❑ Malay
- ❑ Indian
- ❑ Chinese
- ❑ Others (Please state) ____________

3. Gender

- ❑ Male
- ❑ Female

4. Who employs you?

- ❑ Private sector
- ❑ Government
- ❑ Self-employed
- ❑ Unemployed

Others (Please state) ____________

5. What is the highest level of educational level have you attained?

- ❑ Primary school
- ❑ Secondary school
- ❑ Colleges
- ❑ University

Other (Please state) ____________

Thank you for participating in the study
Your answers will be use in strict confidence

I.B. Maakip
Vehicle Safety Research Group
Loughborough University
United Kingdom

Appendix 6

Design of Experiment

Appendix 6

Subjects	Gender	Home to work Experiments Assignments of Traffic Information					
1	Male	1	4	3	2	5	6
2	Female	3	1	2	4	6	5
3	Male	4	3	1	6	2	5
4	Male	5	6	3	1	4	2
5	Female	6	2	4	5	1	3
6	Male	2	4	3	5	6	1
7	Male	2	5	6	1	4	3
8	Female	3	2	4	6	1	5
9	Female	4	1	2	5	3	6
10	Male	2	6	5	1	3	4
11	Male	4	5	2	3	6	1
12	Female	1	4	6	5	2	3
13	Male	5	2	1	3	4	6
14	Male	3	1	6	2	5	4
15	Female	2	3	4	5	6	1
16	Male	4	5	3	1	2	6
17	Male	5	6	1	2	4	3
18	Male	1	4	2	5	3	6
19	Female	4	2	1	3	6	5
20	Female	2	6	5	4	3	1
21	Male	5	1	6	3	4	2

Subjects	Gender	Work to home Experiments Assignments of Traffic Information					
1	Female	2	6	4	1	3	5
2	Male	1	5	2	3	4	6
3	Female	4	2	3	6	1	5
4	Male	5	4	1	3	2	6
5	Male	6	1	4	2	3	5
6	Female	1	4	3	5	6	2
7	Male	2	5	6	3	4	1
8	Female	3	2	4	1	5	6
9	Male	4	1	5	2	6	3
10	Female	1	2	3	5	4	6
11	Male	2	3	1	4	6	5
12	Female	4	5	6	3	2	1
13	Female	6	2	5	1	3	4
14	Male	2	1	3	6	4	5
15	Female	5	4	2	3	1	6
16	Male	6	3	4	1	5	2
17	Male	1	5	6	4	2	3
18	Female	2	6	1	3	4	5
19	Female	4	2	5	6	3	1
20	Male	3	1	4	5	6	2

The assignment of the traffic information based upon the procedures of randomization (Rosenthal and Rosnow, 1991)

Traffic Information

1. Congestion Ahead	2. Congestion Ahead - Delay 1 hours
3. Congestion Ahead - 3 km	4. Congestion Ahead - Follow Diversion Signs
5. Congestion Ahead - Follow Diversion Signs - Delay 1 hours	6. Congestion Ahead - Follow Diversion Signs - 3 km

Appendix 7

Experiment Questionnaire

Universiti Kebangsaan Malaysia

Vehicle Safety Research Group

Experimental checklist

Please answer all the questions. Thanks for your co-operation.

Age : .... Years old

Gender :...................

Ethnics group :.....................

Years of held a full driving licence : .... years

Years of driving experiences :........................ Years

Universiti Kebangsaan Malaysia
Vehicle Safety Research Group

Drivers Information Requirements Study

This is a study regarding drivers information requirements. This study is interested in obtaining your response concerning traffic information that describing congestion.

Task 1

Imagine that you are on your way to work from your home. As you drive along on your regular route, you will be presented with several traffic information regarding congestion on your usual route.

Task 2

Please listen to the traffic information which has been presented to you on each condition. Please listen very carefully.

Task 3

After you had already listen to each of the traffic information. Please answer the question regarding traffic information that you have been listened to.

Thanks for your co-operation

Traffic Information 1 :

Q1 : What would you do ?

....

....

....

Q2 : Reason of your action (Refer to the Q1)?

....

....

....

Q3 : In your opinion, what is the important aspects/theme in the traffic information that has been presented to you, which help you decides what to do next, i.e. your decision?

....

....

....

Q4 : What kind of information did you prefer to be presented to the drivers regarding congestion?

....

....

....

Q5 : If you have any queries, please state in the space provided.

....

....

....

....

....

Traffic Information 2 :

Q1 : What would you do ?

....
....
....

Q2 : Reason of your action (Refer to thc Q1)?

....
....
....

Q3 : In your opinion, what is the important aspects/theme in the traffic information that has been presented to you, which help you decides what to do next, i.e. your decision?

....
....
....

Q4 : What kind of information did you prefer to be presented to the drivers regarding congestion?

....
....
....

Q5 : If you have any queries, please state in the space provided.

....
....
....
....
....

Traffic Information 3 :

Q1 : What would you do ?

....

....

....

Q2 : Reason of your action (Refer to the Q1)?

....

....

....

Q3 : In your opinion, what is the important aspects/theme in the traffic information that has been presented to you, which help you decides what to do next, i.e. your decision?

....

....

....

Q4 : What kind of information did you prefer to be presented to the drivers regarding congestion?

....

....

....

Q5 : If you have any queries, please state in the space provided.

....

....

....

....

....

Traffic Information 4 :

Q1 : What would you do ?

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

Q2 : Reason of your action (Refer to the Q1)?

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

Q3 : In your opinion, what is the important aspects/theme in the traffic information that has been presented to you, which help you decides what to do next, i.e. your decision?

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

Q4 : What kind of information did you prefer to be presented to the drivers regarding congestion?

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

Q5 : If you have any queries, please state in the space provided.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

Traffic Information 5 :

Q1 : What would you do ?

....

....

....

Q2 : Reason of your action (Refer to the Q1)?

....

....

....

Q3 : In your opinion, what is the important aspects/theme in the traffic information that has been presented to you, which help you decides what to do next, i.e. your decision?

....

....

....

Q4 : What kind of information did you prefer to be presented to the drivers regarding congestion?

....

....

....

Q5 : If you have any queries, please state in the space provided.

....

....

....

....

....

Traffic Information 6 :

Q1 : What would you do ?

....

....

....

Q2 : Reason of your action (Refer to the Q1)?

....

....

....

Q3 : In your opinion, what is the important aspects/theme in the traffic information that has been presented to you, which help you decides what to do next, i.e. your decision?

....

....

....

Q4 : What kind of information did you prefer to be presented to the drivers regarding congestion?

....

....

....

Q5 : If you have any queries, please state in the space provided.

....

....

....

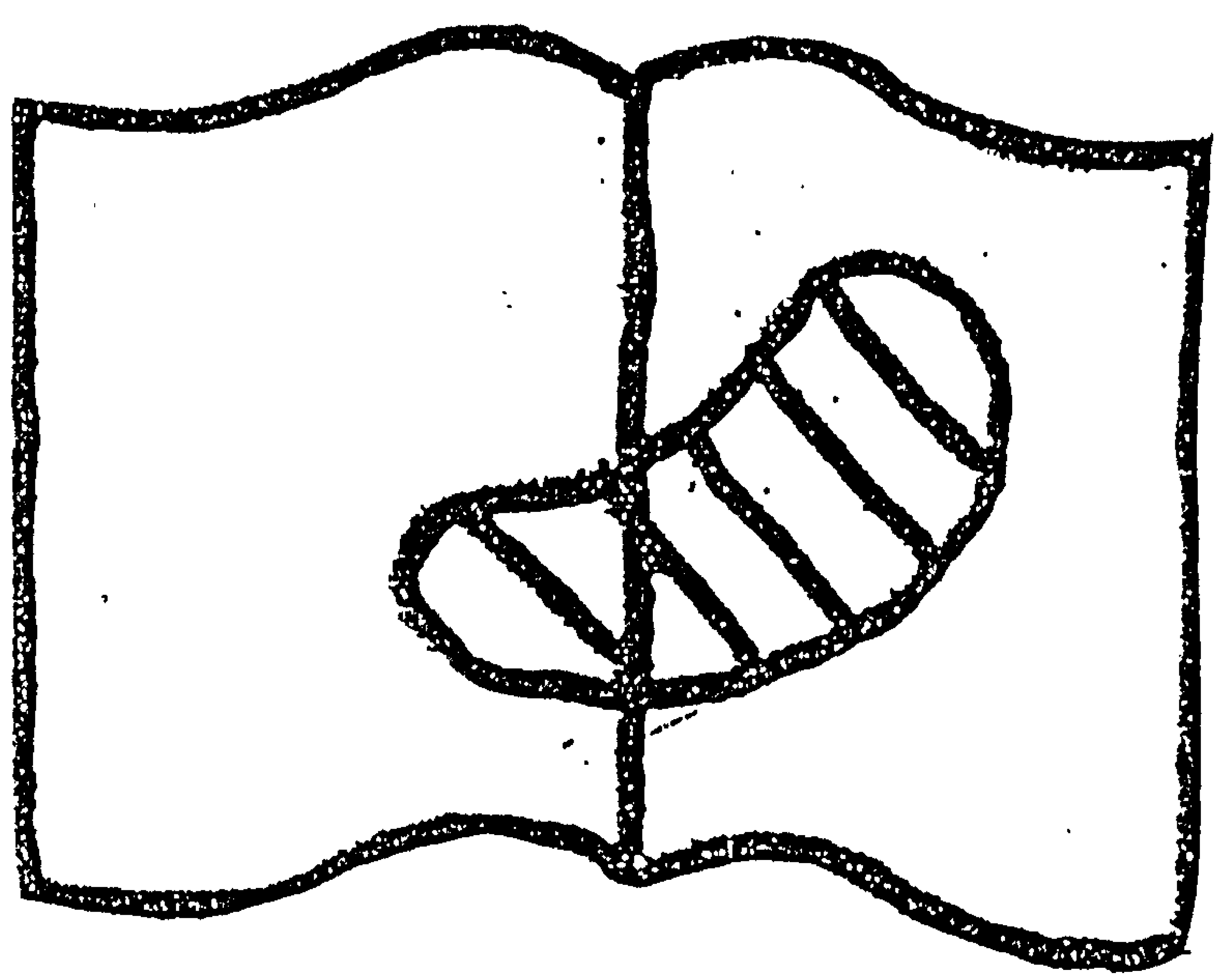
....

....

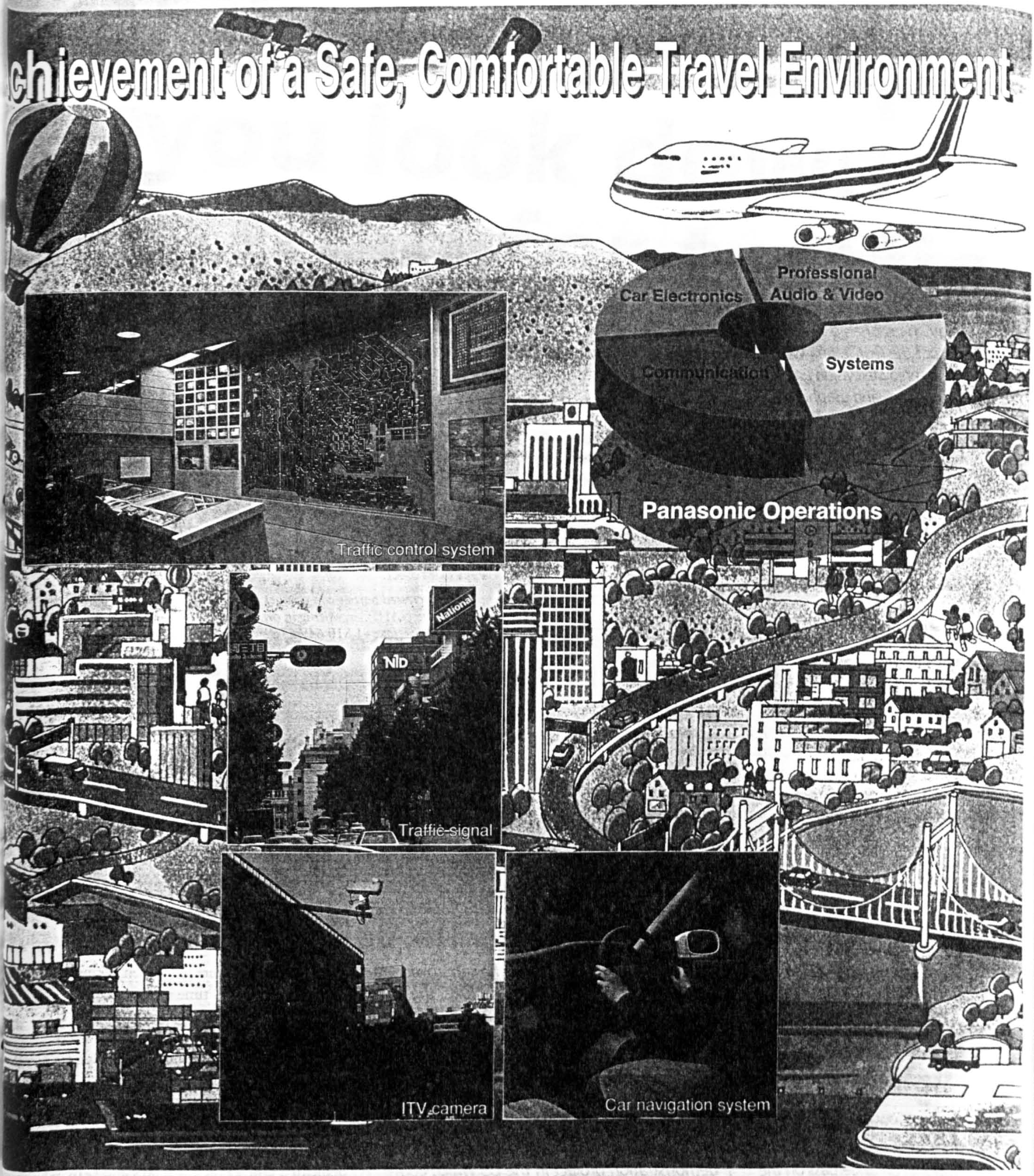
Thanks for your co-operation

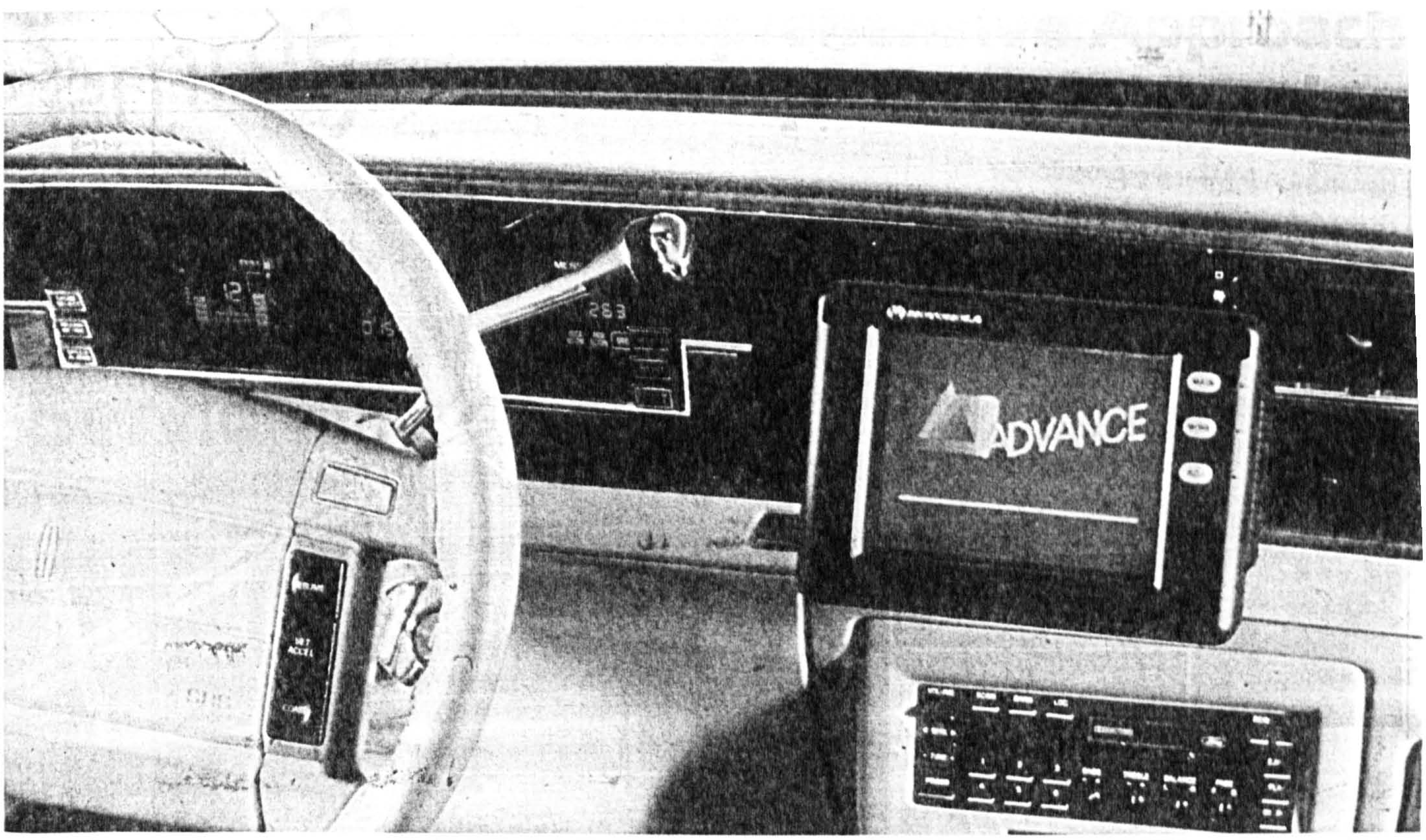
Appendix 8

Example of material used in the study



Text cut off in original


chievement of a Safe, Comfortable Travel Environment
Car Electronics
Professional Audio & Video
Communication
Systems
Panasonic Operations
Traffic control system
Traffic signal
National
ITV camera
Car navigation system



ADVANCE (Advanced Driver and Vehicle Advisory Navigation Concept) is an Advanced Traveler Information System (ATIS) demonstration project located in the northwest suburbs of Chicago, Illinois. ADVANCE seeks to provide dynamic traffic information to vehicles fitted with in-vehicle computers and radio communications equipment. For a seven month period, 75 vehicles are testing ADVANCE dynamic route guidance systems in a 300 square mile area. The vehicles utilize differential GPS navigation as well as dead-reckoning and map-matching to navigate through the study area. The vehicles themselves act as probes, sending real-time travel information to a Traffic Information Center (TIC) that, in turn, transmits the information to other vehicles to aid in dynamic route planning.

The ADVANCE equipment offers route guidance in a real-time framework using information from a variety of existing sources, including a closed loop traffic signal system, *999 (a cellular based motorist call-in system), the Illinois Department of Transportation (IDOT) Traffic Systems Center (which monitors and controls operations on expressways in the Chicago area), IDOT's Communications Center (which communicates with the IDOT Emergency Traffic Patrol, the motorist aid system), Northwest Central Dispatch (a six community 911 emergency dispatch system) and other sources. The primary source of information, however, is the vehicles themselves acting as traffic probes.

The ADVANCE project consists of four subsystems, namely: the TIC, which contains the central facility and the operator interface; the Traffic Related Functions (TRF) which includes the traffic algorithms; the Communications Subsystem (COM) which provides message carrying capability between the TIC and the vehicles in the field; and the Mobile Navigation Assistant (MNA) which contains in-vehicle route planning and display capabilities. The TIC and the TRF are the direct responsibility of the Universities, while the MNA and COM are the responsibility of Motorola. Both the TIC software and the TRF software reside on the TIC central computer and, as such, the integration of these two subsystems has been critical.

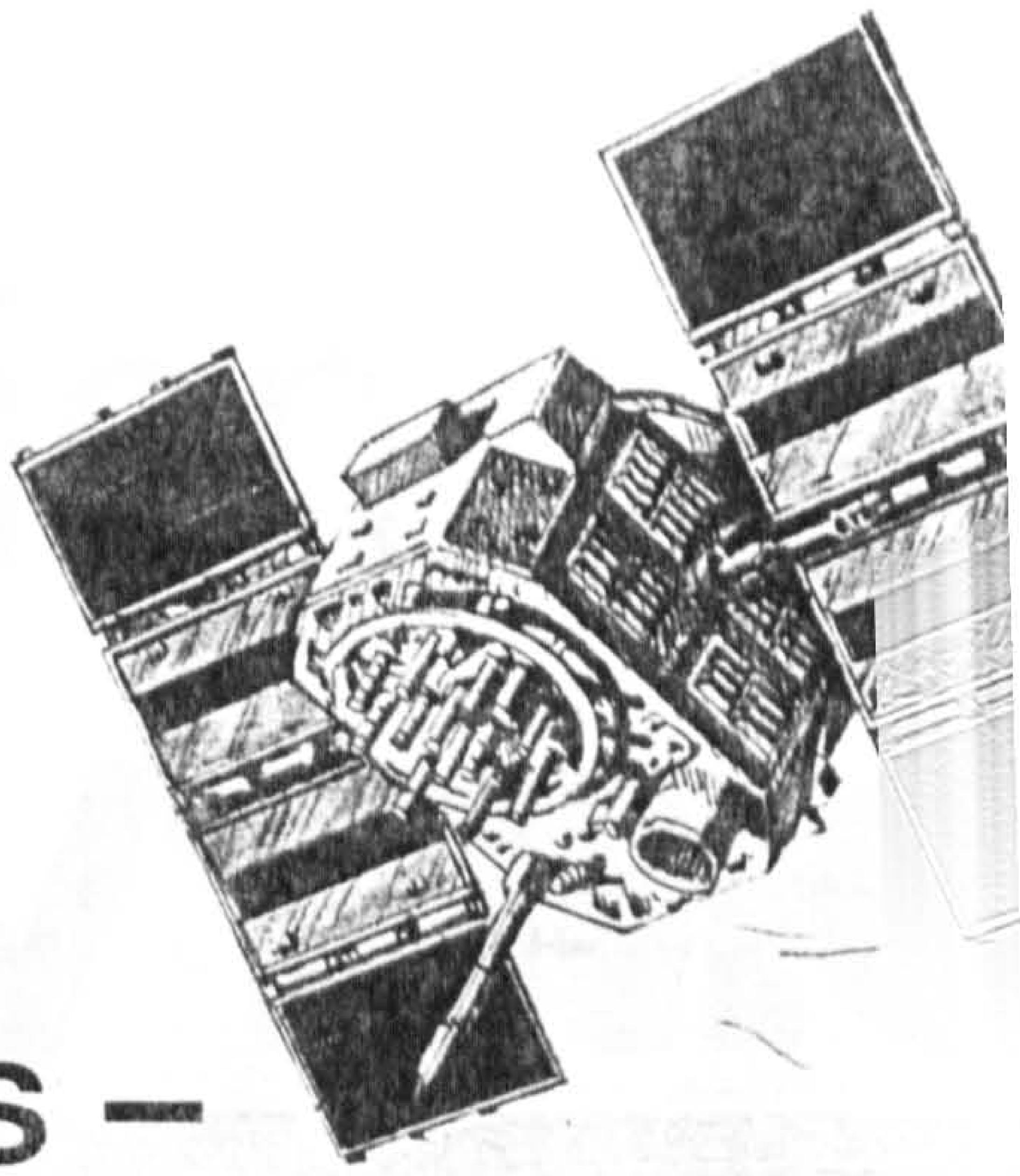
"the question was considered whether a more targeted deployment could achieve many of the original objectives of the project at a significantly reduced cost"

TARGETED DEPLOYMENT

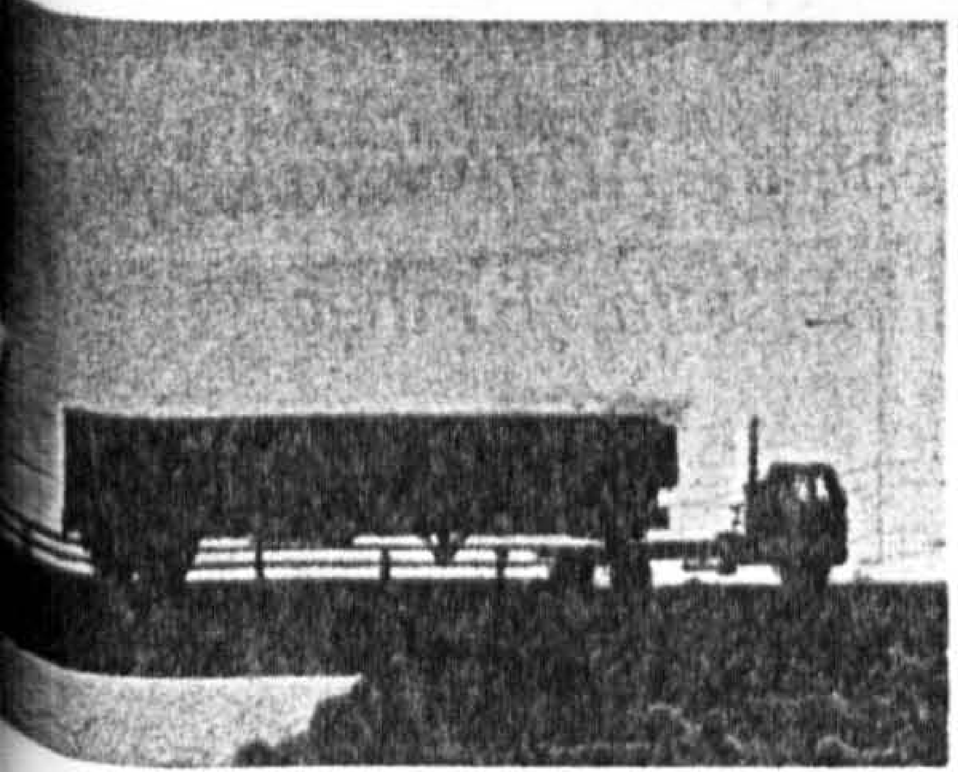
The project has been divided into two phases, the Development Phase and the Targeted Deployment Phase. Each phase contains several design releases. The different releases allow the software and hardware components to be phased in over time so that products can be developed and tested incrementally as additional functionality is provided. The Development Phase was completed in May, 1995. The Targeted Deployment Phase began in June 1995 and will be complete by the end of December 1995.

To ensure the success of the ADVANCE project, an overall integration plan document has been developed which details how each subsystem is integrated

MANNESMANN AUTOCOM

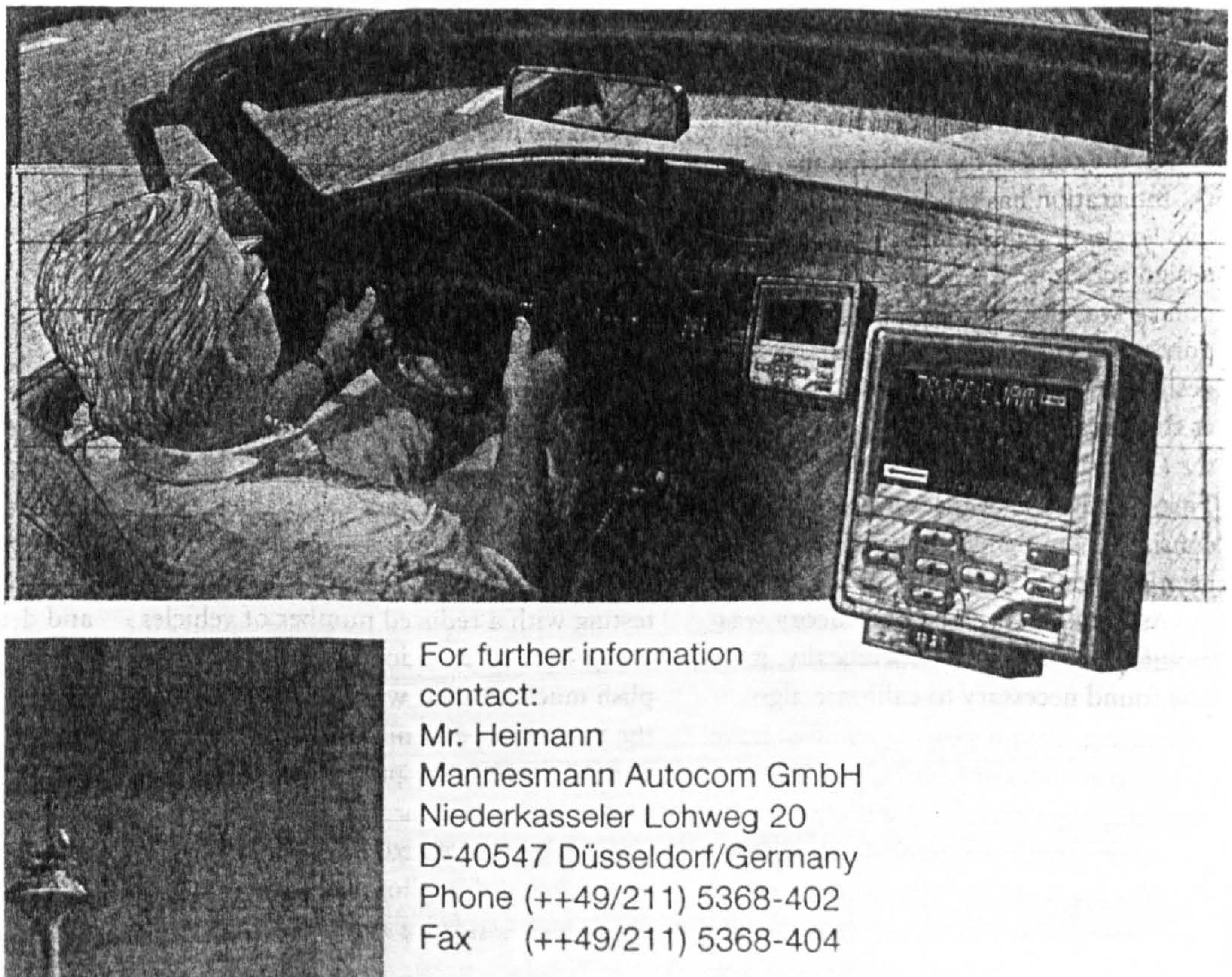


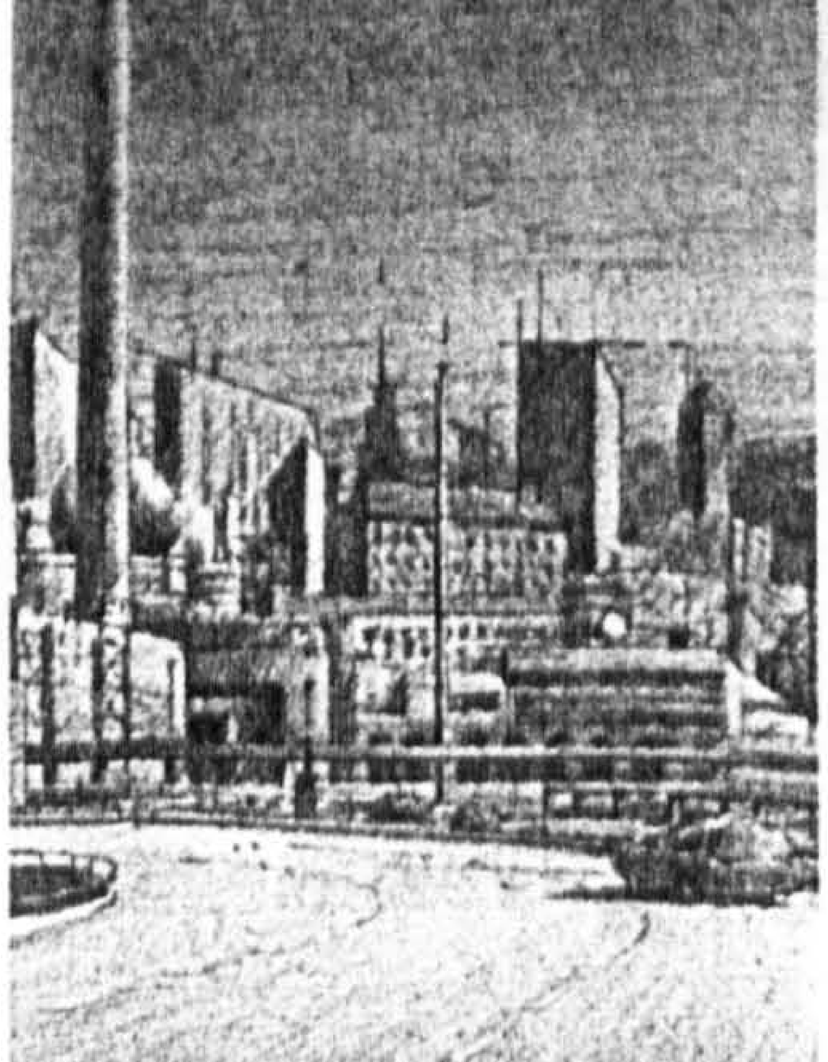
Traffic Telematics – Services based on GPS and GSM



We are in the process of implementing and marketing various traffic telematic products such as safety, security and emergency call-out services, traffic information services and fleet management services. These are all based on a combination of satellite-aided positioning (GPS) and mobile telecommunications (GSM).
Our service package will be introduced gradually and on a region-by-region basis. Our strategic objective is to achieve pan-European availability of an intelligent traffic management capability. Soon individual drivers owners and operators of vehicle fleets, and public transport services alike will be able to profit from this, our contribution to a brighter, more mobile future.

Mannesmann Autocom is helping to ensure that tomorrow's traffic keeps on the move. Together with other member companies of the Mannesmann Group we have developed an all-encompassing concept offering a comprehensive range of traffic telematic services. At the core of this concept is the commitment to full openness to different networks and terminal equipment, thus enabling effective cooperation with other system suppliers and service providers.





For further information contact:
Mr. Heimann
Mannesmann Autocom GmbH
Niederkasseler Lohweg 20
D-40547 Düsseldorf/Germany
Phone (++49/211) 5368-402
Fax (++49/211) 5368-404

Mannesmann
Machinery · Automotive
Telecommunications

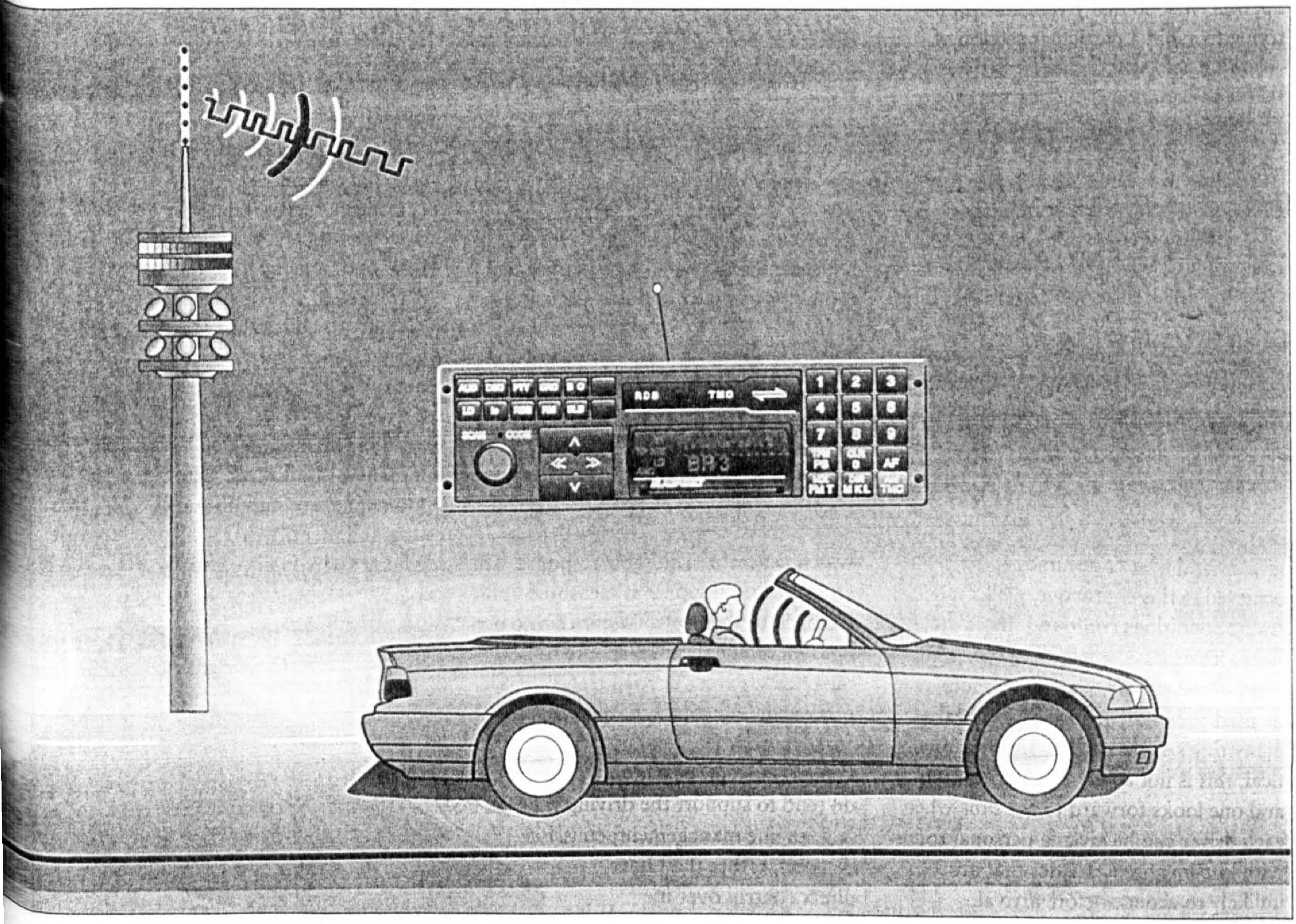
Traffic information using RDS/TMC

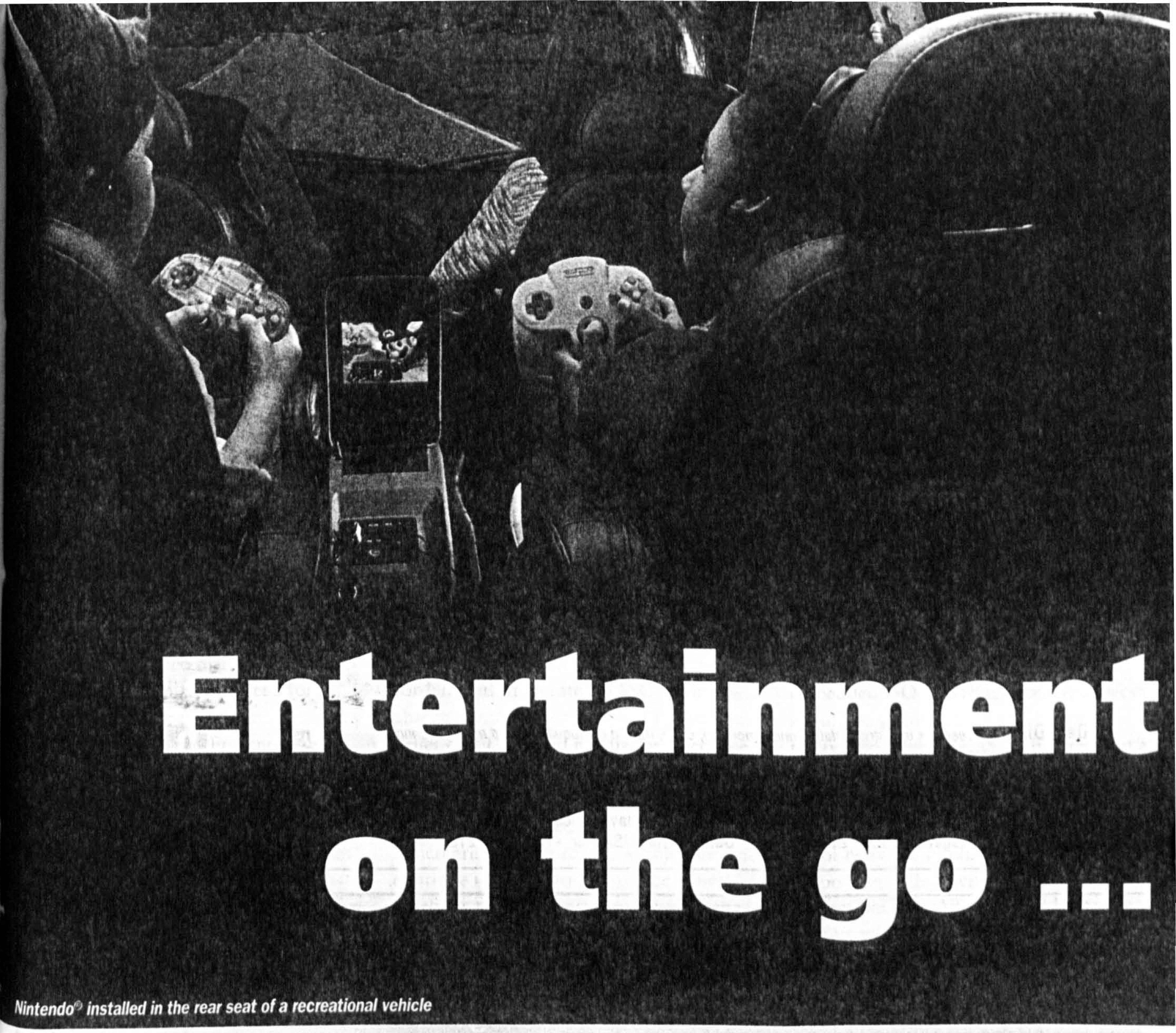
Georg Obert, BMW AG, Munich, Germany

Provision of up-to-date relevant traffic information is critical if drivers are to be able to make the best decisions regarding trip planning and route selection and in order to integrate public transport into their journey planning. For this reason RDS/TMC has been an important component in the Munich COMFORT field trials where seventy per cent of test participants preferred RDS/TMC to conventional radio traffic broadcasts

The volume of traffic on roads and motorways is continually increasing, but there are no plans to expand the traffic infrastructure to cope with this situation. The provision of extensive information to road-users is therefore becoming increasingly important. With the latest information at their fingertips, they can plan trips better before they set off or alternatively change their route during the trip.

Thanks to the existing ARI System (German driver radio information service), it is possible to locate a traffic



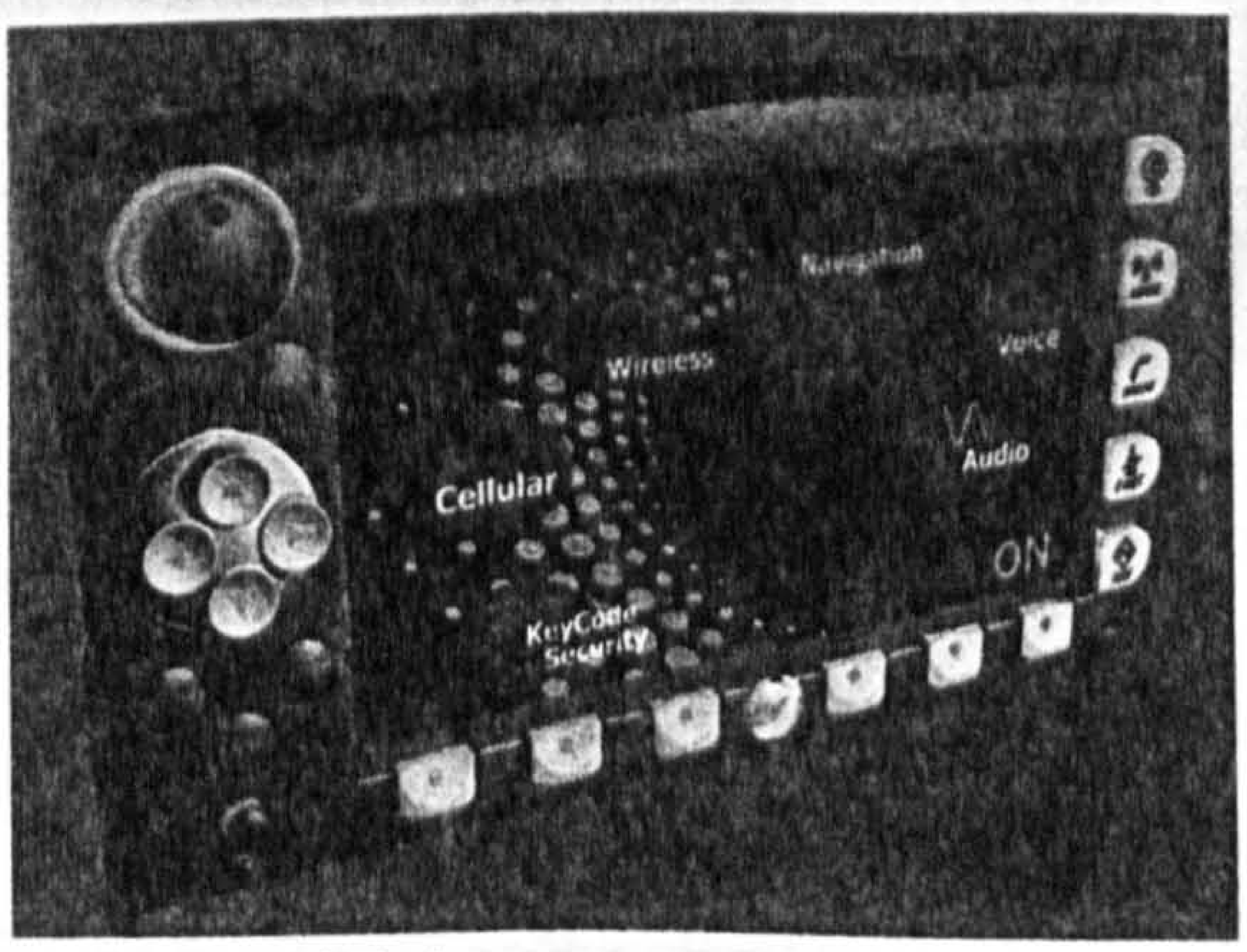


Entertainment on the go ...

Nintendo® installed in the rear seat of a recreational vehicle

L. Smyth & J. Kibilko, Visteon Automotive Systems, USA

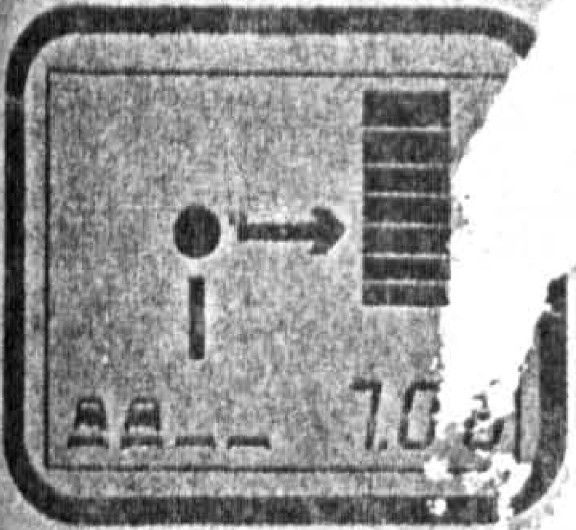
The time we spend in our vehicles just seems to increase as we have more to do and more places to be to keep the basics of our lives in order. However, safety remains the primary consideration as Visteon blurs the distinction between the home and the office through telematics and multimedia



Visteon's ICES in-dash screen

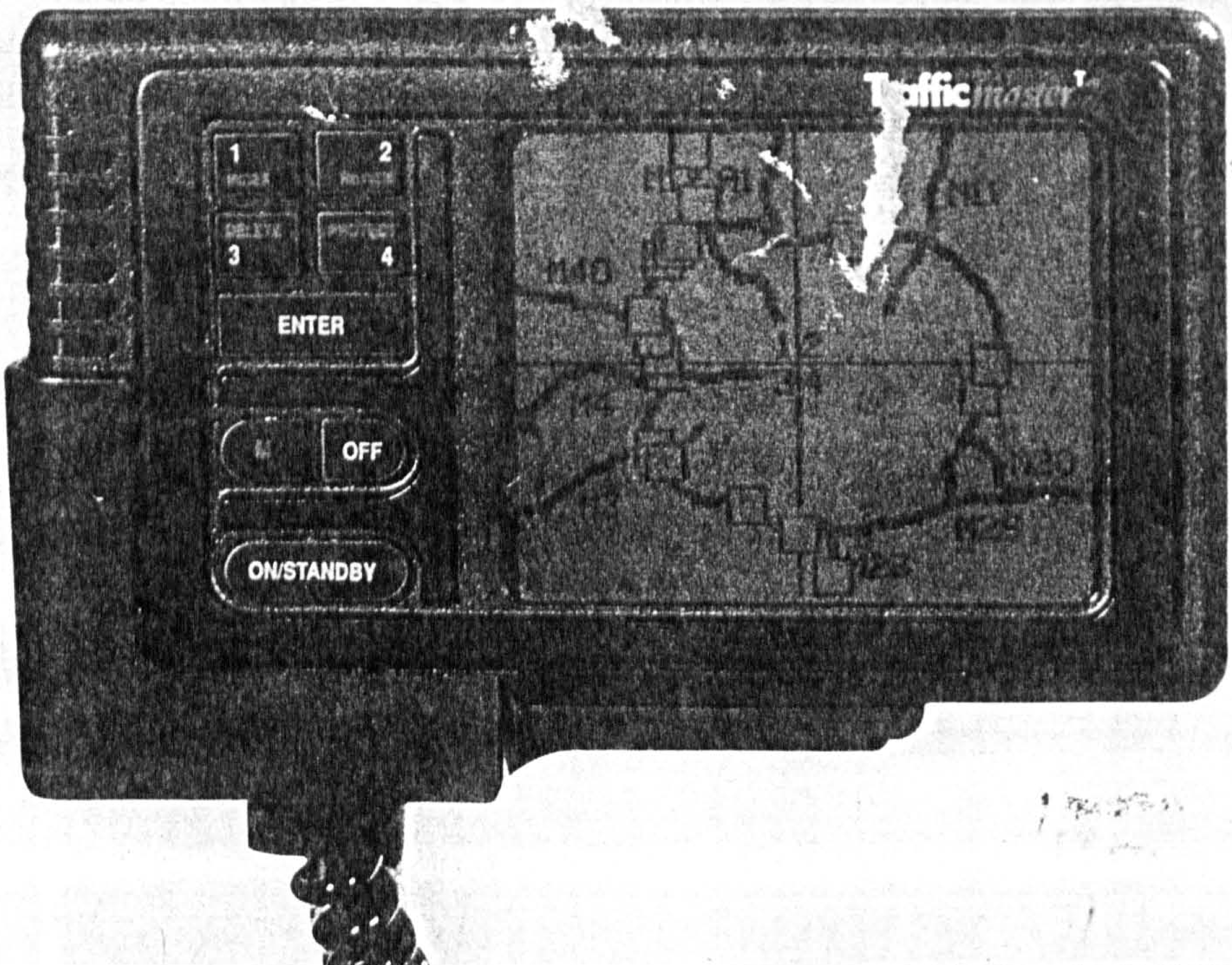
Let's face it. We've all been guilty of it: cruising down the freeway fumbling with the buttons on our radio, or looking for that crumpled piece of paper with directions to an anniversary party you're trying to find. Don't you wish there were a way to bridge the gap between home and car?

Well, now there is, due to a little help from Visteon Automotive Systems. Since its launch at the Frankfurt Motor Show in September 1997, Visteon has been unwavering in its goal to make its customers successful and become the world's leading full-service automotive systems supplier. Visteon is combining nearly a century of experience with an emphasis on fully integrated systems and a global marketing plan to increase non-Ford business to 20 per cent. Led by chairman and CEO, Pete Pestillo, Visteon is



Harmonisation of ATT Roadside and Driver Information in Europe

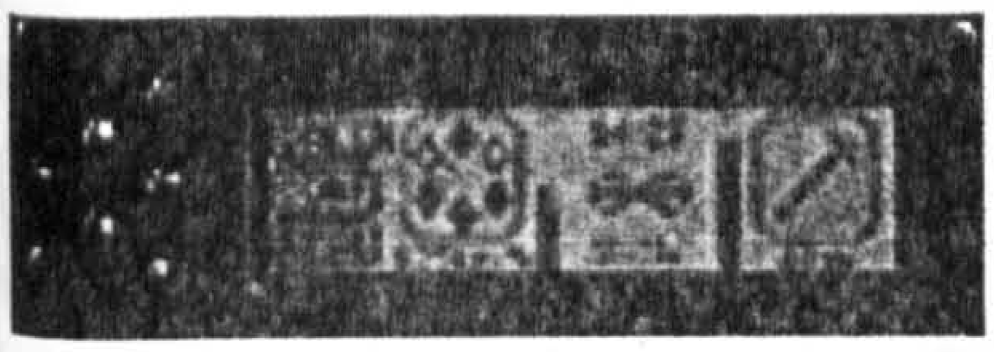
New t nno' make it possible to provide drivers with increc ing amounts of information both inside the vehicle, using displays, speech or tactile messages, and from outside the vehicle such as road signs and Variable Message Signs. Processing such information will require a growing amount of the driver's time and concentration.



HARDIE is Project V2008 in the EC DRIVE II programme of research and development in Advanced Transport Telematics (ATT)


You have won
the Lottery!
say "Yes" to accept
Your share portfolio
has peaked - suggest
reroute funds
10/24/1999
Thursday
3:31
Start
My Computer
Imaging
For Help, press F1

In-vehicle navigation **without** in-vehicle data overload



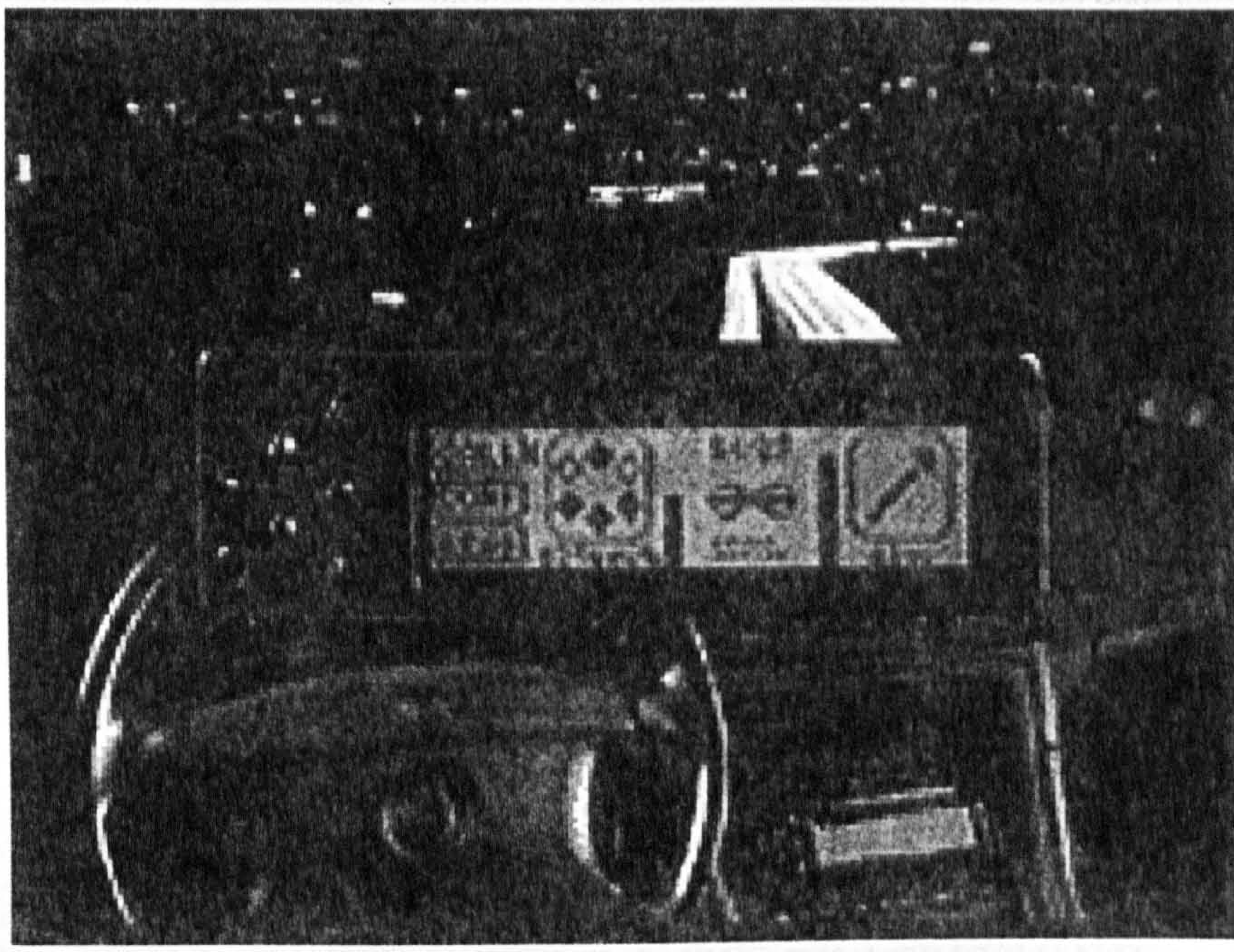
German-US joint venture ComRoad developed the Mobile On-line Information Centre as a map database to provide navigation to equipped vehicles without the need to have maps and navigation software loaded into each vehicle. Navigation instructions are transmitted to each moving vehicle in real time, displayed in the vehicle as text and directional graphics.

The on-line centre can also provide driver information, on-line computer services and mobile office support to each vehicle. Communications are radio data communications, used for receipt of vehicle GPS locations and transmission of navigation instructions.

In the vehicle is a car-radio sized unit containing a six-channel GPS receiver and LCD display. A wireless data modem supports Modacom, ARDIS, Mobitex/RAM, CDPD or GSM-SMS communications protocols.

Also available are traffic flow and accident information, weather conditions and news broadcasts. Access to financial services, airline reservations, and the Internet are possible. Combining this with fax and print-out capabilities, the unit effectively allows a vehicle to be converted to a mobile office.

For more information, contact Bodo Schnabel, ComRoad AG, Tel: +49 89 31 57 19 21, Fax: +49 89 31 51 694, Email: bodo@solidinfo.com, Web: www.solidinfo.com or tick reader enquiry card BB19



Traffic+IS=ITS

LEE is a leading engineering firm with extensive experience in the planning, design, implementation and operation of ITS. The company assumes a wide range of services as both traffic and information systems specialist.

Consulting services include traffic studies, defining operation procedures, and preparing handbooks for incident management and customer information. The company also prepares user information systems engineering using VMS, RDS-TMC, Internet, and DATEX. For traffic control centres, LEE undertakes the integration of hardware and software systems.

Traffic software products are also developed by the firm, covering traffic forecasts, vehicle classification, automatic incident detection, traffic simulation and operation procedures simulation.

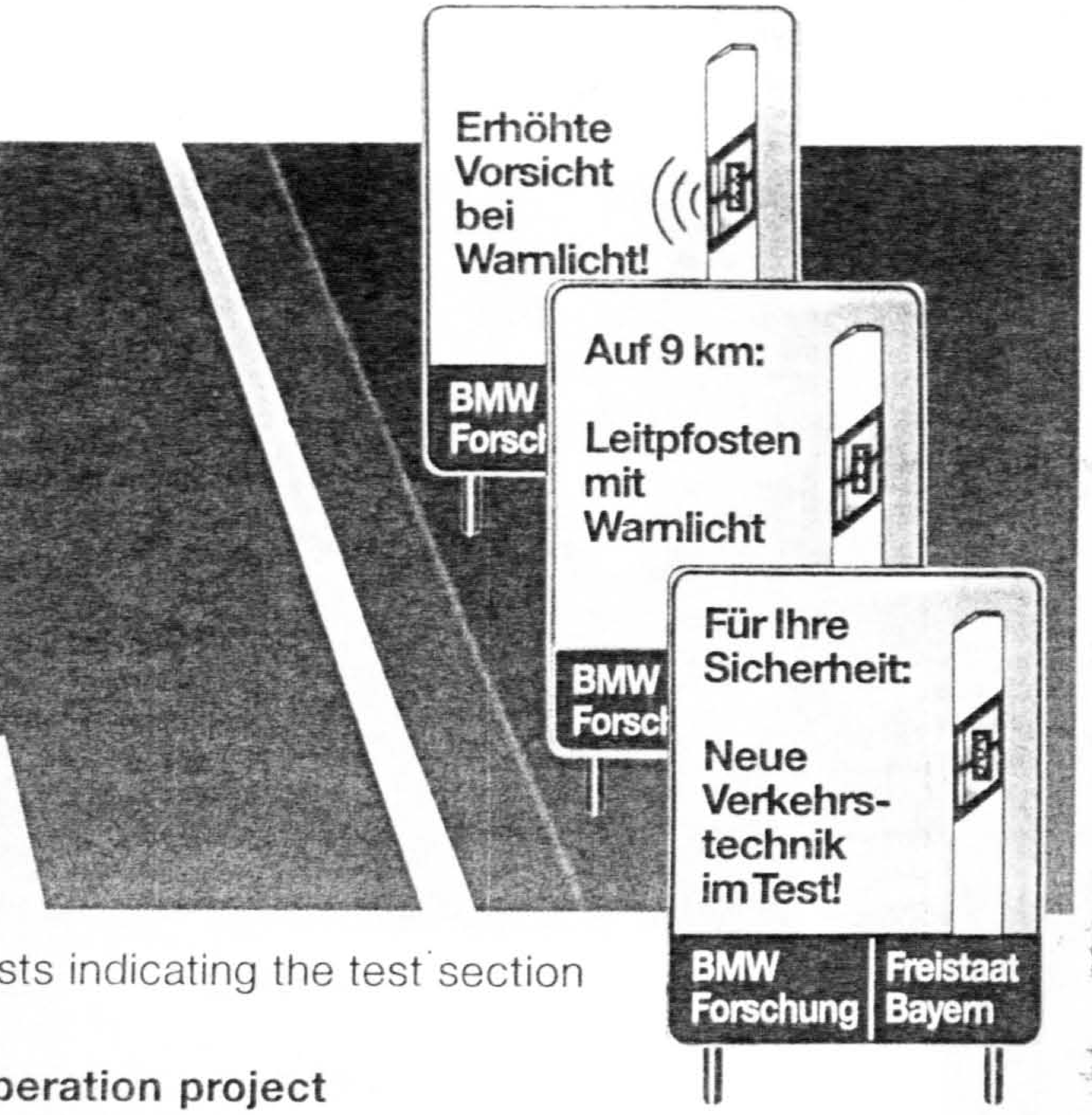
LEE takes on board outcomes of EC projects and participates as an active partner in many of them.

Since its establishment in 1979, LEE has been making continuous and conscientious attempts to develop projects in partnership with clients. Being responsive to the needs of its customers with unmatched dedication and skill, the company has earned a good reputation as a leading consulting and engineering firm, especially in public transportation and highway systems. Strict quality control is enforced at every stage of each project, using software tools that check for accuracy, consistency and completeness.

Technical know-how includes software development for real-time and database systems, GIS, EIS and data warehouses, and telecommunication systems and network protocols. The company also provides expertise in up-to-date technologies: client/server, object-oriented conception and programming, artificial intelligence, fuzzy logic and neural networks.

From the preliminary and detail design to the operation and maintenance training and start-up, LEE is a professional traffic partner to introduce ITS for today.

For further information contact Michel Chavret, LEE Tour Gamma A 193–197 rue de Bercy, 75582 Paris Cedex 12, France, Tel: +33 4 72 11 47 60, Fax: +33 4 72 12 17 17, Email: leefr@planete.net or tick reader enquiry card BB20



sts indicating the test section

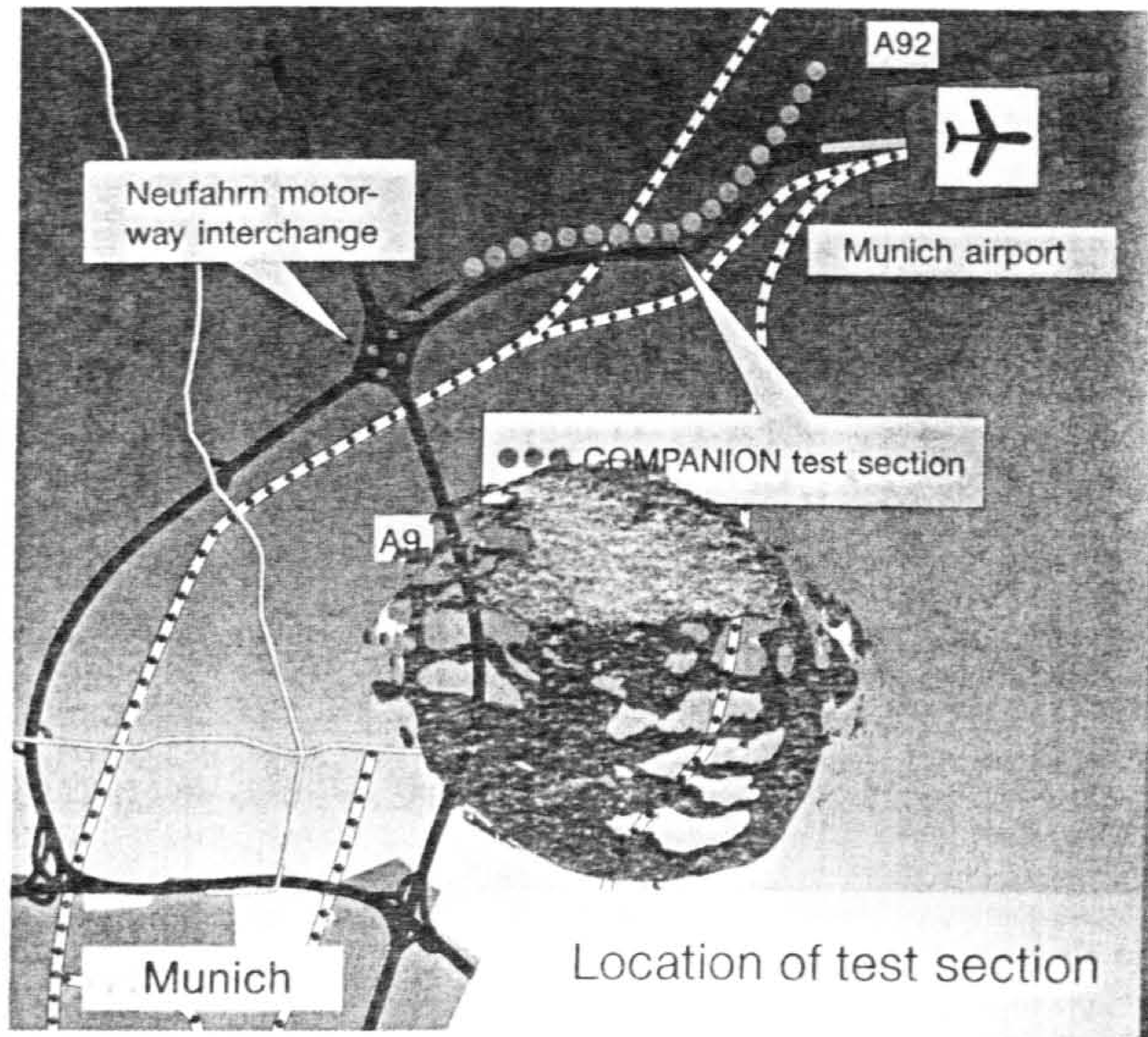
peration project

co-operation with the transport authorities of the
ate of Bavaria, the ADAC (German Automobile Asso-
and industrial partners, BMW Research has installed
MPANION warning system along a test section of
motorway. The 9-km-long test section is situated
orth of Munich near the airport on the southbound
way of the motorway.

ge trial design

1 (optical warning by means of light signals, starting
nd of 1995), the light signals in the new beacons will
ated in the event of an incident using conventional
es and automatically detected measured data.
cons will be controlled by the South Bavarian traffic
centre in the Freimann district of Munich.

2 (starting in 1997), vehicles will be able to partici-
raffic data acquisition for the first time by anonymous
erchange (visual warnings and communications).
ransceiver on board the vehicle will send valuable
he beacons and will receive updated traffic informa-



Location of test section

Flashing signals: Please slow down, be ready to brake. There may be a tailback, accident, roadworks, a vehicle driving on the wrong carriageway or an ADAC breakdown vehicle ahead.

COMPANION: Advanced warning system.

Milestone: A 4-digit number on the rear of the beacon indicates your position correct to the nearest 50 metres.

Communications: Interchange of data between vehicle and roadside equipment to increase road safety.

Self-destruction: If a beacon is removed illegally, its electronics automatically self-destruct.

System fail-safe: A missing beacon will not cause the failure of the entire system. The monitor reacts immediately.

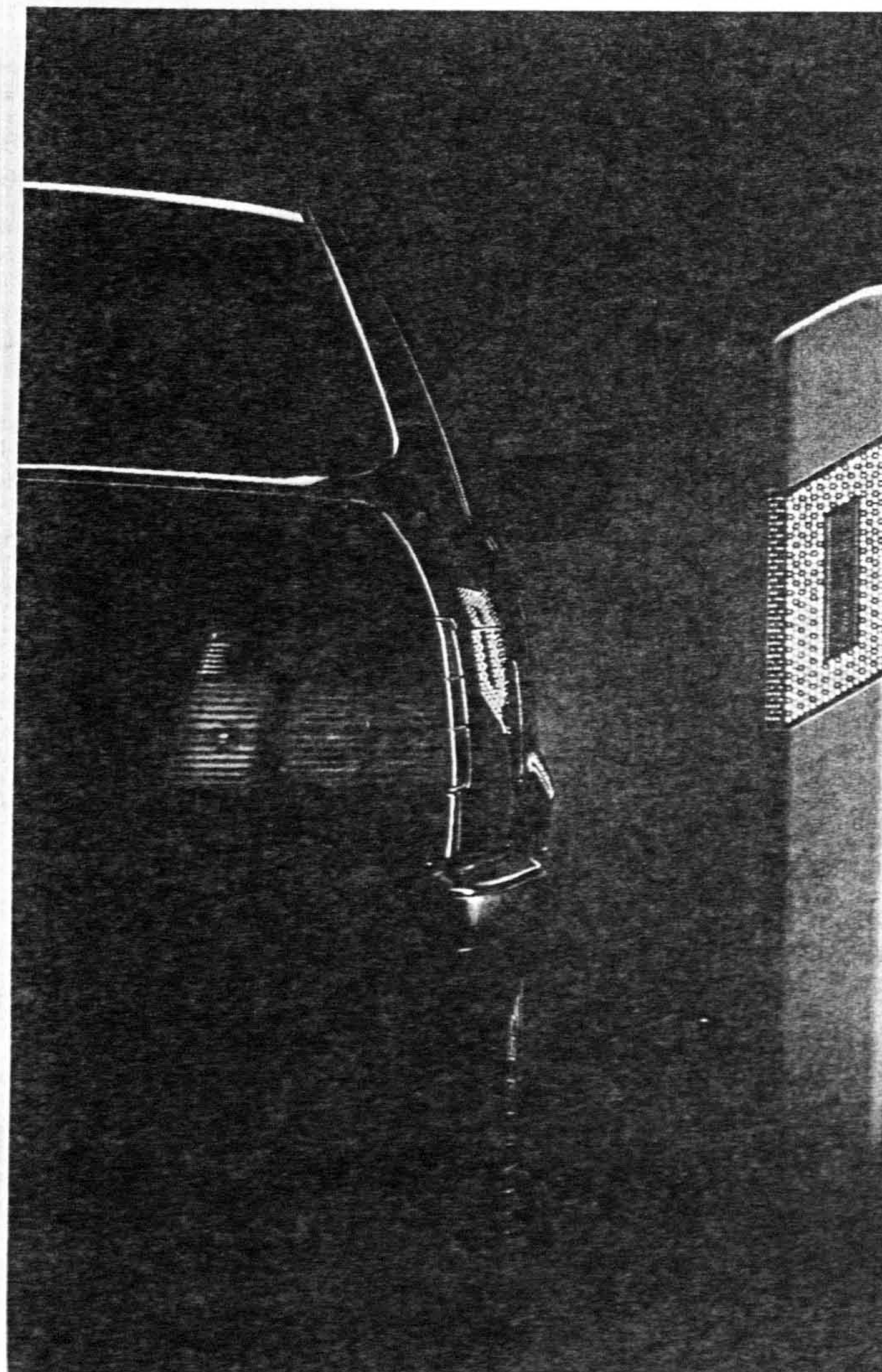
Test start: End of 1995.

Test section: Situated in the north of Munich near the airport.

BMW AG Munich 1995

COMPANION®

A collective warning system to supplement traffic management systems on very busy motorways



traffic incident occurs ...

ccident with a tailback

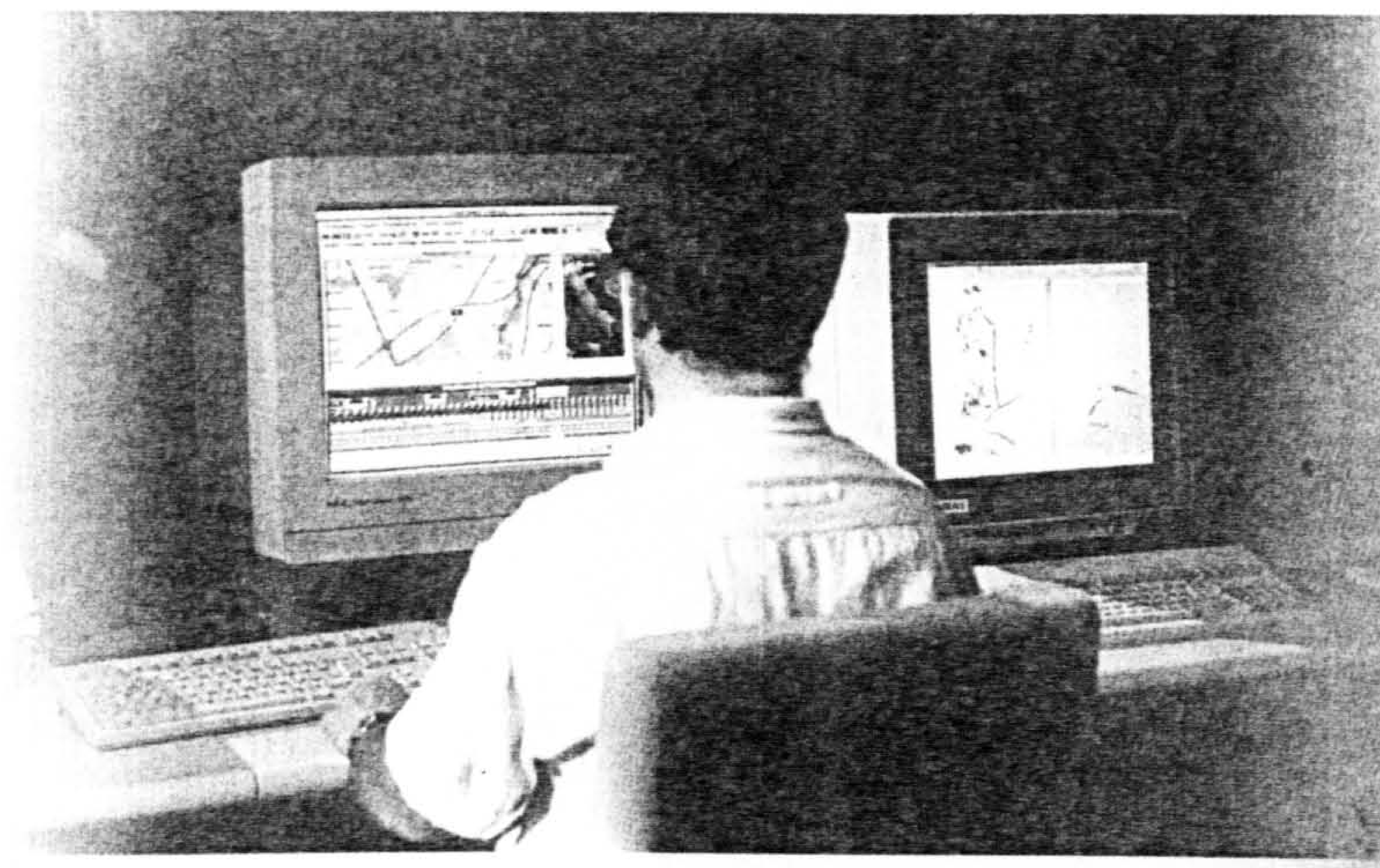
og on the motorway ...
truck has broken down ...
o chance of warning following
affic in time ...

his type of accident and many others, gether with their grave consequences, an be avoided if incidents are detected nmediately and reported, and if the accident ocation can be cordoned off straight away.

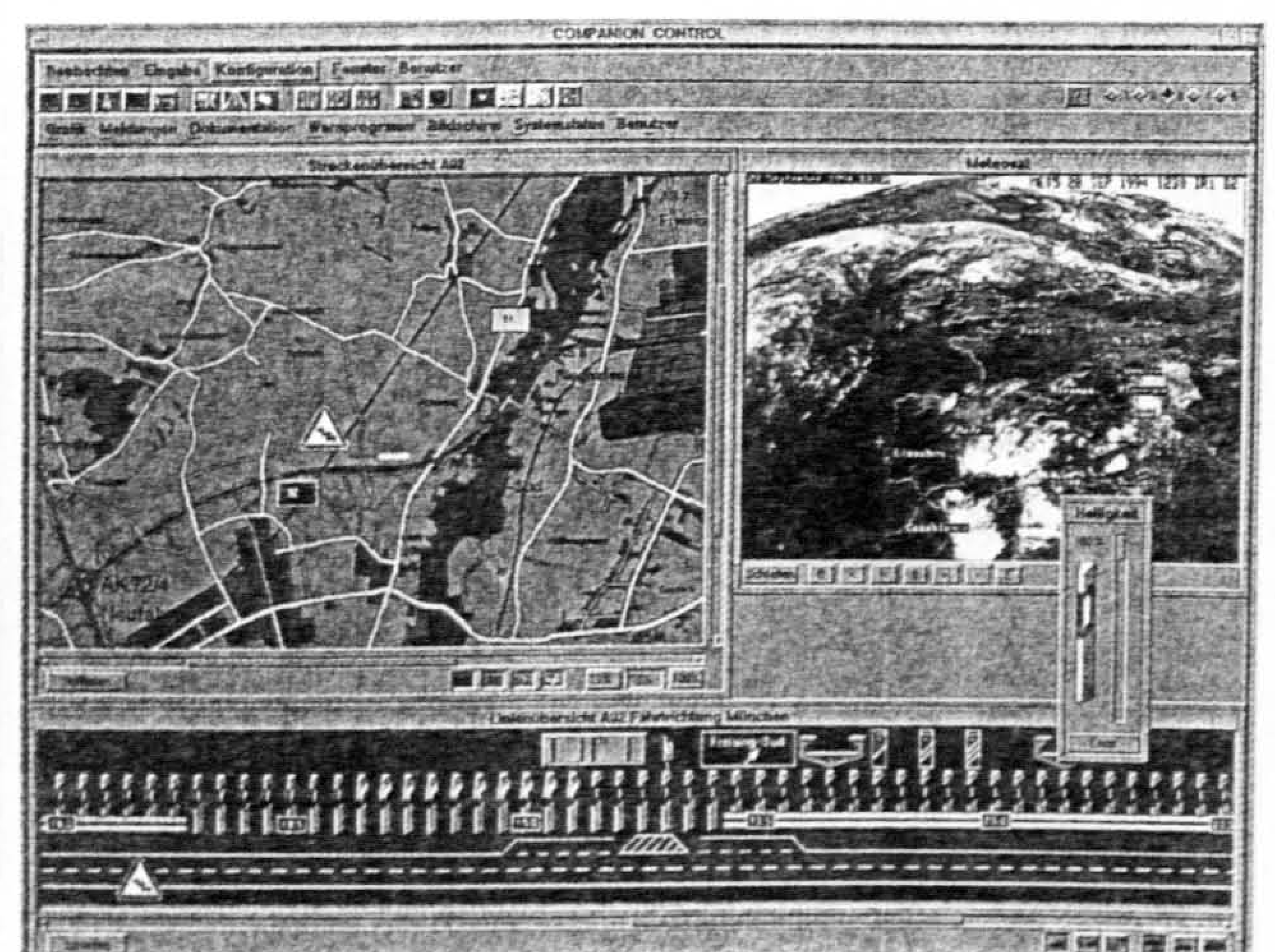
OMPANION was developed to perform this ask – as an efficient supplement to existing nd future traffic management systems.

Germany, there are about 4,000 km of ery busy motorway sections. In the whole f Europe, this figure is over 20,000 km. he criteria for this are high traffic density, igh accident figures and frequently poor sibility, e.g. caused by fog or bad run of he road.

... the traffic computer centre receives
a message ...



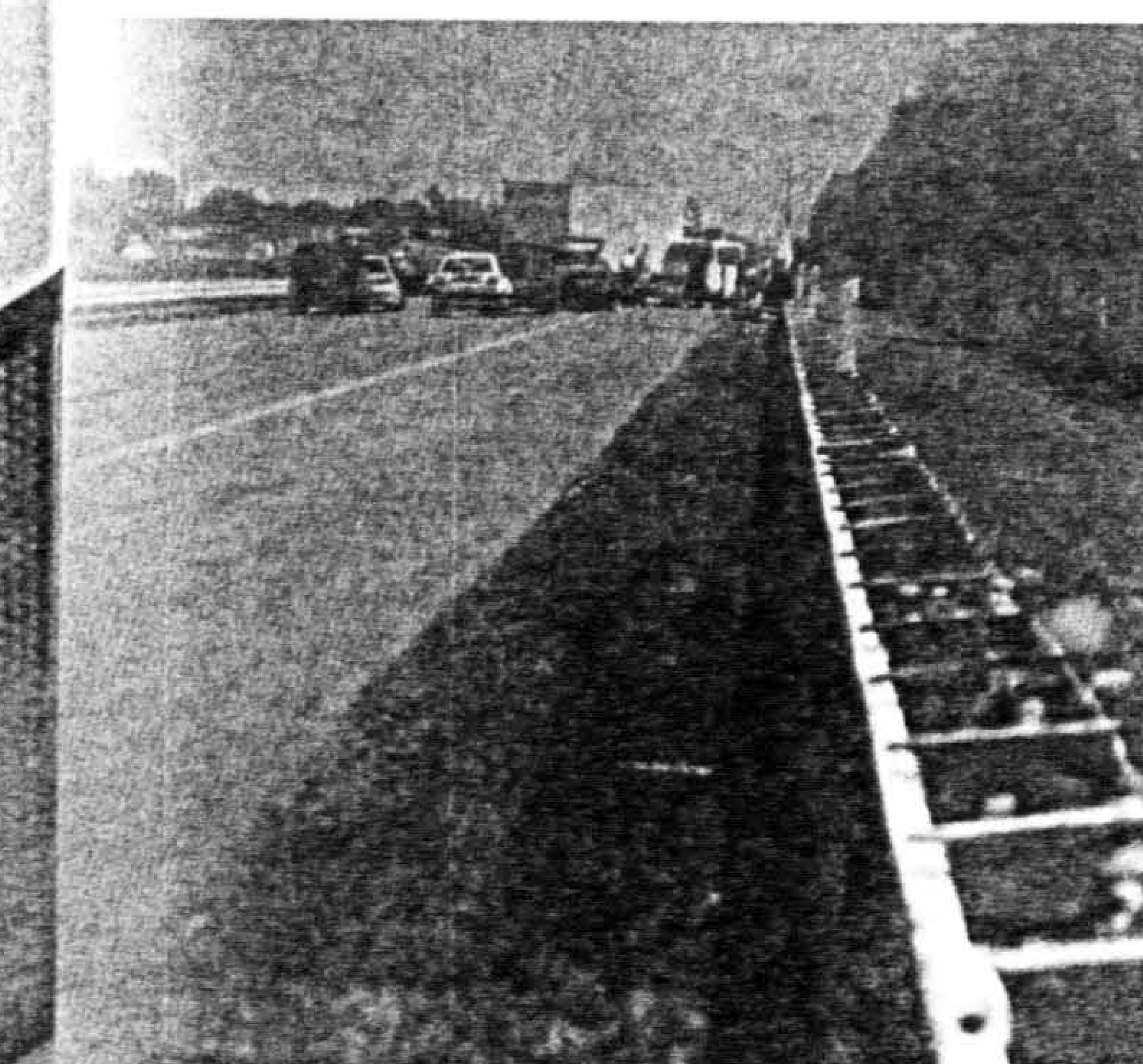
Operator in traffic computer centre



COMPANION CONTROL graphical user interface

Traffic incident messages normally still arrive at the computer centre along conventional channels – from emergency telephones along motorways and roads or from car telephones. The use of automatic detection by traffic telematic systems

... and immediately switches
on light signals to warn follow
traffic.



Light signals give warnings in split sec

COMPANION is a collective warning
system to supplement traffic manag
systems on very busy motorways.

Conventional marker posts will be repla by new beacons equipped with a light u and additional electronics. The beacons interconnected by cable and linked to a computer centre. From there, the light s can be activated to flash warnings with seconds until the police arrive on the s to cordon off the accident area. In the e of tailbacks, accidents, fog and ice, yell amber light signals can warn approach traffic.

In a later expansion stage, active, anon vehicle data will be radioed to the beac This data will contain information on ve model and speed or the activity of warn flashers, fog lamps, windscreen wipers, alarms or ABS.