EVALUATING DRIVER PERCEPTION TO THE EFFECTIVENESS OF INTEGRATED TRANSPORT INFORMATION SYSTEM (ITIS): AN ORDERED LOGIT APPROACH

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Khoo Hooi Ling

Faculty of Engineering and Science
Universiti Tunku Abdul Rahman
53300 Setapak, Kuala Lumpur, Malaysia
E-mail: khoohl@utar.edu.my

ABSTRACT

This study aims to investigate driver perceived effectiveness to the implementation of traffic information dissemination system, i.e. Integrated Transport Information System (ITIS) in Klang Valley region, Malaysia. Five evaluation indicators are chosen, namely usefulness, accuracy, reliability, satisfaction, and benefits of travel time saving. Using revealed preference study, drivers are asked to evaluate the system's effectiveness based on these indicators. The level of awareness and utilisation of the system is studied as well. Ordered logit models are developed to analyse the significant contributing factors to the perceived effectiveness. Results indicate that drivers perceived radio as the most effective tool. Although some of them perceived negatively to the accuracy and reliability of the system, about 56% of them commented that the system is useful while most of them anticipated that the current system could be further improved in the future.

1.0 INTRODUCTION

Nowadays, it is generally accepted that traffic congestion could not be alleviated through construction of more highways. From the demand and supply point of view, better management of road traffic through the implementation of the Intelligent Transportation System (ITS) is highly regarded as a more economic and effective alternative. Advanced Traveler Information System (ATIS) that disseminates traffic information aims to change the driver traveling decision in order to achieve better and more efficient transportation facility and resource allocation. Two types of traffic information could be disseminated, namely pre-trip information and en-route information. Pre-trip information can be disseminated through radio, internet, and TV which aims to affect the mode choice and departure time choice of travelers. The en-route information could be disseminated through radio and variable message signs (VMS) which is normally real time traffic information which aim to help drivers in avoiding traffic congestion by adjusting their route choice.

There are many existing studies that pertaining to the evaluation of the effectiveness of ATIS. Nevertheless, these studies share some limitations. First, most of the studies focused on investigating the awareness and utilisation of ATIS information. To name a few: in US, Peng and Guequierre [1] found that the awareness of VMS information is affected by the frequency of drivers encountering VMS signboards, the drivers' thrust on the information provided, and the drivers perceived usefulness of VMS information. Mannering *et al.* [2] found that males are less likely to perceive traffic information as important and the factors affecting awareness level are: drivers' socio economic characteristics, habitual travel pattern, congestion levels and attitude towards technology. In terms of utilisation, Spyridakis *et al.* [3] carried out a study on drivers' route choice behavior in Seattle, US. They found that drivers are more likely to divert to known routes and more willing to change their routes from work than from home. The willingness of drivers in route changing is affected by traffic message delivered, traffic congestion level, time of day, weather and time pressure. In Los Angeles, US, Abdel-Aty *et al.* [4] found that male drivers are more risk prone and willing to change route, commuters value and use pre-trip information more than en-route, drivers who perceived higher information reliability more prone to route change, and drivers on longer distance tend to choose alternative roads. However, these studies could only measure the system's effectiveness in an indirect way. They could not explain how drivers perceived the quality of the services and the value of the information provided. As the service provider, it is crucial to understand driver opinion and experience pertaining to the system which could help enhancing the services for better future market penetration. Second, most studies tend to focused on VMS (for example, [1] and [5]) and little research study has been carried out for other ATIS tools.

Nonetheless, the effectiveness of the overall ATIS system should not be represented by the popularity of only one tool. How other tools being utilised could also affect the overall system's effectiveness and thus vital to give due consideration to them. Third, there is little study for Malaysian cities. Although the ITIS system was developed in the Klang Valley region since year 2005, there is no research studies carried out to investigate the effectiveness of the system. Only recently, Roshandeh and Che-Puan [6] carried out a field study on VMS and found that the travel time could be reduced by 19.7% and the occupancy is shortened by 5.3%. However, more studies are necessary in order to understand the drivers' response and behavior towards the system besides learning the limitations of the system. One should not assume that drivers in Klang Valley will behave similarly as those who lived in other cities. This is simply because the living status and style, the educational background and the new technology acceptance of travelers could be different.

The objective of this study is to investigate the effectiveness of the traffic information dissemination system (such as radio, internet, and variable message sign) in the Klang Valley region, Malaysia, from the view point of drivers. Accordingly, a revealed preference questionnaire study is carried out to interview the drivers in the region in order to collect their opinion and comments on the system. Five important indicators are chosen to quantify the effectiveness of the system, namely the usefulness, accuracy, satisfaction, reliability, and travel time saving. Drivers are required to rate the performance of the system in a 5-scale Likert scale based on these indicators. In addition, the awareness and utilisation of traffic information is surveyed as well. It is expected that drivers' perceived effectiveness of the system is highly related to how drivers aware and utilise the information provided. The level of awareness is expressed in terms of frequency the traffic information is obtained via various traffic information tools while the level of utilisation is measured in terms of driver adjustments to the departure time or route for a trip. The findings from the questionnaire are analysed by developing the ordered logit models. The factors significantly affecting the perceived effectiveness are studied. Besides, the relationship among the effectiveness, awareness and utilisation are investigated. It is anticipated that this study could provide a comprehensive understanding of the traffic information system as well as the driver response to the system.

2.0 STUDY AREA

The study area chosen for this study is the Klang Valley region, which comprises Kuala Lumpur (the capital of Malaysia) and its neighboring sub-urban cities and towns. The region is located in the state of Selangor and is the nation's main industrial and commercial region. Over the years, the region has achieved strong economic growth compared to other states in Malaysia and such performance has attracted migration from other states. Population in the region has grown from 4 million in 2004 to 6 million in 2007. Along with the growth in economy and increase in population size, the private vehicle population has also increased by about 150%, from 2.2 million in 1996 to 5.5 million in 2008. About 55% of these vehicles are private cars, 35% motorcycles, 0.37% buses, 0.59% taxis, 5% trucks and 4% other types of vehicle [7]. Use of private transportation has also increased and the modal split of private vehicles to public transportation has changed from 75%:25% in 1985 to 84%:16% in 2006. The increased use of automobiles has resulted in traffic congestion in the region, causing average traffic speeds on the major roads being reduced to a critical level.

In 2005, the government has decided to develop a traffic information system to help improving the current traffic management system in the Klang Valley region. The Integrated Transport Information System (ITIS) developed by the City Hall Kuala Lumpur (CHKL), the governing authority of the region, is a combination of the existing Advanced Traffic Management System (ATMS) and Advanced Traveler Information System (ATIS). The ITIS collect traffic data from the detectors and closed circuits television cameras installed on the roadways. It is also equipped with the automatic incident detection system to detect the occurrence of unexpected incidents. Transport Management Centre (TMC) is set up to process, manage and analyse the traffic data. The centre will then disseminate the updated near-real time traffic information to drivers in the region.

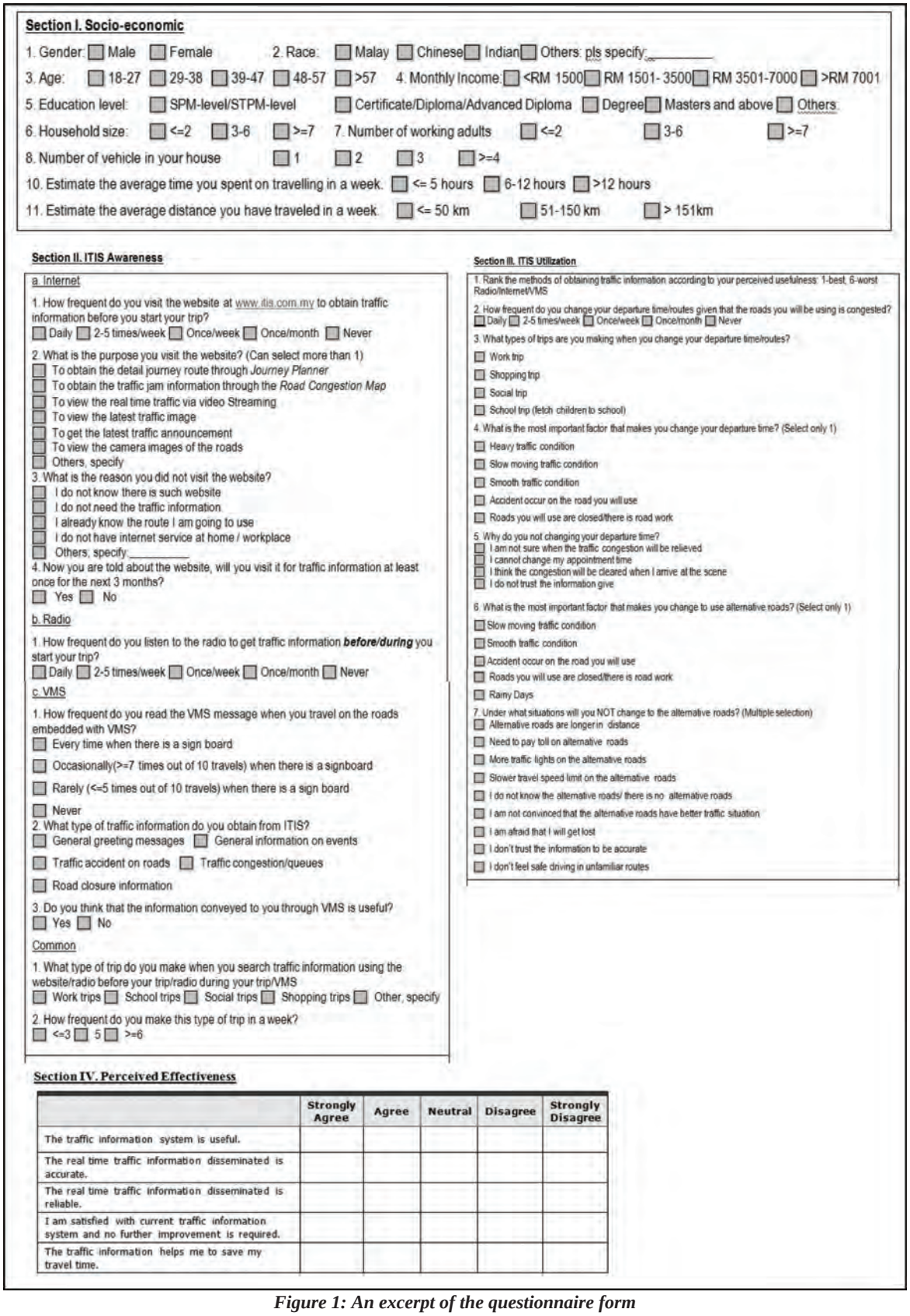
Currently, the system covers all major roads in the Kuala Lumpur Federal territory. A total of over 200 km of roads, which cover 45 arterial roads, is monitored [8]. The system is developed with a cost of RM 365 million. This large-scale project involved the installation of over 250 closed-circuit television (CCTV) cameras for traffic monitoring at key intersections, 700 video-based vehicle detector stations, 140 variable message signs (VMS) and 1600 units of vehicle tracking units to serve as dynamic probes. There are various tools used in ITIS to disseminate traffic information. The most common tools are internet, radio, and VMS. The ITIS Portal [9] provides a lot of valuable traffic information. For example, *Congestion Map* provides the real time traffic situation on the roadways; *Journey Planner* provides the detailed route from an origin to a destination. Furthermore, users could obtain the real time traffic and latest traffic image via video streaming on the website. Recently, another website (*www.llmtraffik.com.my*) is set up by the Malaysia Highway Authority (MHA) to provide real-time traffic information on most of the expressways in the Klang Valley region. Besides the internet, one can also rely on either VMS or radio for updated traffic information. For example, myFM (101.8 Hz), one of the famous Chinese radio programmes, periodically reports traffic conditions in the region between 7am and 9am in the morning and between 5pm and 8pm in the evening daily.

3.0 METHODOLOGY

3.1 Questionnaire Survey Study

A revealed preference (RP) questionnaire survey was designed to investigate drivers' perceived effectiveness of the system. Besides, it also aims to probe the relationship between the level of awareness and utilisation of the system to the perceived effectiveness. An excerpt of the questionnaire is shown in Figure 1. The questionnaire comprises four sections. Section I is related to the socio-economic and travel characteristics of the drivers. Socio-economic characteristics include gender, race, age, monthly income, education level, household size, number of working adults and number of vehicles in the house. For the travel-related characteristics, respondents have to estimate their average weekly travel time and distance they spent on traveling each week. Section II of the questionnaire is divided into three sub-sections to study the awareness and the utilisation of the ITIS system, namely the internet, radio, and VMS. Questions asked in

each sub-sections include the frequency of the tool being used to obtain traffic information, the trip purpose, and the number of trips generated weekly. The respondents are then asked to provide reasons for not adopting any particular traffic dissemination tool. For radio, an additional question is asked to check if the respondent is aware of traffic information availability by other means (pre-trip and en-route). Section III of the questionnaire is related to the utilisation of traffic information on their travels. Utilisation of traffic information is tracked by checking if drivers have made changes in their departure time choice and/or route choice after receiving information from each tool. In the case where respondents chose not to make any adjustments after receiving the traffic information, they were asked to provide a reason. In Section IV, the respondents were asked about their



Section I. Socio-economic

1. Gender: ☐ Male ☐ Female 2. Race: ☐ Malay ☐ Chinese ☐ Indian ☐ Others: pls specify:_____
3. Age: ☐ 18-27 ☐ 29-38 ☐ 39-47 ☐ 48-57 ☐ >57 4. Monthly Income: ☐ <RM 1500 ☐ RM 1501- 3500 ☐ RM 3501-7000 ☐ >RM 7001
5. Education level: ☐ SPM-level/STPM-level ☐ Certificate/Diploma/Advanced Diploma ☐ Degree ☐ Masters and above ☐ Others
6. Household size: ☐ <=2 ☐ 3-6 ☐ >=7 7. Number of working adults ☐ <=2 ☐ 3-6 ☐ >=7
8. Number of vehicle in your house ☐ 1 ☐ 2 ☐ 3 ☐ >=4
10. Estimate the average time you spent on travelling in a week. ☐ <= 5 hours ☐ 6-12 hours ☐ >12 hours
11. Estimate the average distance you have traveled in a week. ☐ <= 50 km ☐ 51-150 km ☐ > 151km

Section II. ITIS Awareness

a. Internet

1. How frequent do you visit the website at www.itis.com.my to obtain traffic information before you start your trip?
☐ Daily ☐ 2-5 times/week ☐ Once/week ☐ Once/month ☐ Never
2. What is the purpose you visit the website? (Can select more than 1)
☐ To obtain the detail journey route through *Journey Planner*
☐ To obtain the traffic jam information through the *Road Congestion Map*
☐ To view the real time traffic via video Streaming
☐ To view the latest traffic image
☐ To get the latest traffic announcement
☐ To view the camera images of the roads
☐ Others, specify
3. What is the reason you did not visit the website?
☐ I do not know there is such website
☐ I do not need the traffic information
☐ I already know the route I am going to use
☐ I do not have internet service at home / workplace
☐ Others, specify:_____
4. Now you are told about the website, will you visit it for traffic information at least once for the next 3 months?
☐ Yes ☐ No

b. Radio

1. How frequent do you listen to the radio to get traffic information ***before/during*** you start your trip?
☐ Daily ☐ 2-5 times/week ☐ Once/week ☐ Once/month ☐ Never

c. VMS

1. How frequent do you read the VMS message when you travel on the roads embedded with VMS?
☐ Every time when there is a sign board
☐ Occasionally(>=7 times out of 10 travels) when there is a signboard
☐ Rarely (<=5 times out of 10 travels) when there is a sign board
☐ Never
2. What type of traffic information do you obtain from ITIS?
☐ General greeting messages ☐ General information on events
☐ Traffic accident on roads ☐ Traffic congestion/queues
☐ Road closure information
3. Do you think that the information conveyed to you through VMS is useful?
☐ Yes ☐ No

Common

1. What type of trip do you make when you search traffic information using the website/radio before your trip/radio during your trip/VMS
☐ Work trips ☐ School trips ☐ Social trips ☐ Shopping trips ☐ Other, specify
2. How frequent do you make this type of trip in a week?
☐ <=3 ☐ 5 ☐ >=6

Section III. ITIS Utilization

1. Rank the methods of obtaining traffic information according to your perceived usefulness: 1-best, 6-worst
Radio/Internet/VMS
2. How frequent do you change your departure time/routes given that the roads you will be using is congested?
☐ Daily ☐ 2-5 times/week ☐ Once/week ☐ Once/month ☐ Never
3. What types of trips are you making when you change your departure time/routes?
☐ Work trip
☐ Shopping trip
☐ Social trip
☐ School trip (fetch children to school)
4. What is the most important factor that makes you change your departure time? (Select only 1)
☐ Heavy traffic condition
☐ Slow moving traffic condition
☐ Smooth traffic condition
☐ Accident occur on the road you will use
☐ Roads you will use are closed/there is road work
5. Why do you not changing your departure time?
☐ I am not sure when the traffic congestion will be relieved
☐ I cannot change my appointment time
☐ I think the congestion will be cleared when I arrive at the scene
☐ I do not trust the information give
6. What is the most important factor that makes you change to use alternative roads? (Select only 1)
☐ Slow moving traffic condition
☐ Smooth traffic condition
☐ Accident occur on the road you will use
☐ Roads you will use are closed/there is road work
☐ Rainy Days
7. Under what situations will you NOT change to the alternative roads? (Multiple selection)
☐ Alternative roads are longer in distance
☐ Need to pay toll on alternative roads
☐ More traffic lights on the alternative roads
☐ Slower travel speed limit on the alternative roads
☐ I do not know the alternative roads/ there is no alternative roads
☐ I am not convinced that the alternative roads have better traffic situation
☐ I am afraid that I will get lost
☐ I don't trust the information to be accurate
☐ I don't feel safe driving in unfamiliar routes

Section IV. Perceived Effectiveness

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The traffic information system is useful.					
The real time traffic information disseminated is accurate.					
The real time traffic information disseminated is reliable.					
I am satisfied with current traffic information system and no further improvement is required.					
The traffic information helps me to save my travel time.					

Figure 1: An excerpt of the questionnaire form

opinion on the effectiveness of ITIS system. They are required to express in a Likert scale (strongly disagree to strongly agree, on a five-point scale) on the usefulness, accuracy, reliability, satisfactory, and benefit of travel time saving of the system.

The survey was conducted from October 2nd 2009 to December 31st 2009 in Klang Valley region. A team of 15 trained interviewers conducted their surveys at shopping malls, petrol kiosks, schools, and other facilities in the Klang Valley region. Target respondents are drivers with valid licenses with sufficient driving experiences. A total of 1,506 respondents were interviewed during this period. Table 1 shows the summary of the characteristics of the respondents.

Table 1: Characteristics of respondents

Variables	Category	Percentage	Variables	Category	Percentage
Gender	Male	51%	Household size	<=2	18%
	Female	49%		3-6	68%
Race	Malay	28%		>=7	14%
	Chinese	56%	Number of working adults in a household	<=2	56%
	Indian	15%		3-6	42%
Age	18-28	58%		>=7	2%
	29-38	24%	Vehicle ownership in a household	1	38%
	39-47	12%		2	32%
	48-57	5%		3	18%
	>57	1%		>=4	12%
Monthly income	<RM 1,500	33%	Average weekly travel time	<=5 hours	35%
	RM 1,501-3,500	49%		6-12 hours	46%
	RM 3,501-7,000	16%		>12 hours	19%
	>RM 7,001	2%	Average weekly travel distance	<=50 km	32%
Education level	SPM/STPM	23%		51-150 km	42%
	Diploma	26%		>151 km	26%
	Degree	44%			
	Master and above	3%			
	Others	5%			

3.2 Modelling Approach: Ordered Logit Models

Five criteria are listed to evaluate the perceived effectiveness of ITIS, namely: usefulness, reliability, accuracy, satisfactory, and travel time saving. Drivers are required to rate how agree are they on the performance of ITIS based on these criteria on a 5-scale Likert scale, ranging from strongly disagree to strongly agree. Hence, the responses are discrete ordered variables. Ordered probability models are a form of discrete outcome model that relate the dependent variables in an ordered discrete scale to independent variables which can be continuous or discrete. They are derived by defining an unobserved variable y^* that is used as a basis for modeling the ordinal data [10].

This unobserved variable is typically defined as a linear function for each observation such that:

$$y_i^* = \boldsymbol{\beta}\mathbf{X} + \varepsilon \tag{1}$$

where $\mathbf{X}$ is a vector of independent variables for observation i, $\boldsymbol{\beta}$ is a vector of estimable parameters and ε is a random disturbances. Accordingly, the observed ordinal data y_i for each of the observation is defined as:

$$y_i = \begin{cases} 0 & \text{if } z \le \mu_0 \\ 1 & \text{if } \mu_0 \le z \le \mu_1 \\ \dots & \\ N & \text{if } z \ge \mu_{N-1} \end{cases} \tag{2}$$

where μ are the thresholds that define y that associate to the integer ordering and N is the highest integer ordered response. The values of μ and $\boldsymbol{\beta}$ are estimated from the data using the econometric software, Nlogit. Logit models are obtained if the disturbance term, ε is assumed to be Gumbel distributed. Without any loss of generality, μ_0 in eqn. (2) can set to be zero. It is important to note that the $\boldsymbol{\beta}$ in eqn. (1) does not imply the effect of the changes of $\mathbf{X}$ on y_i. The effect of the changes should be checked based on the marginal effect computation. In this research study, 0 is awarded to the answer of strongly disagree, 1 for disagree, and so on where 4 is awarded for strongly agree.

The categorical variables adopted in this study, such as household size, weekly average traveling distance, frequency of exposure to ITIS information, and others are modeled as continuous variables in the logit models. It is an alternative way of modeling categorical variables besides representing them as the dummy variables. The choice of the modeling approach, however, would not affect the credibility of the results obtained. Interested readers could find more information from Green [10].

4.0 MODELING RESULTS AND ANALYSIS

Prior to the modeling, the drivers' perceived effectiveness obtained from the questionnaire is shown in Figure 2. It is observed that the percentage of drivers perceived ITIS as useful, accurate and reliable are 56%, 35%, and 40% respectively (by taking into consideration of those agree and strongly agree).

About 45% of the respondent perceives that the system could help to reduce travel time. However, only 17.9% of the respondent satisfies with the current system.

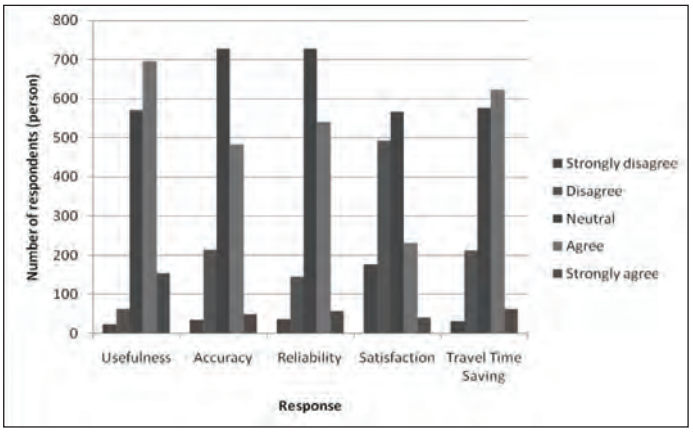


Figure 2: Respondents' perceived effectiveness of ITIS

4.1 Perceived Usefulness

The perceived usefulness describes driver opinion on how useful is the traffic information for their trips. This could include benefits obtaining from static information for trip planning and guidance as well as real time traffic information which help to avoid traffic congestion. Table 2 shows the ordered logit model for the drivers' perceived usefulness which is significant at 95% confidence level. The factors affecting the perceived usefulness are such as: attributes of drivers, travel characteristics, and types of ITIS tools.

Drivers with more number of adults in the household and with low vehicle ownership perceived the information to be more useful. This is reasonable as low vehicle ownership indicates that they need to share cars which resulted in requiring more traffic information for trip planning purposes. Drivers who have longer traveling distance perceived ITIS information as useful. This is because trip planning needs to be carried out for longer distance trip. Besides, drivers who perceived traffic information as useful are most likely to obtain information from radio. However, there is no relationship found between perceived usefulness and the level of traffic information utilisation.

Table 2: Ordered logit model for drivers' perceived usefulness

Variable	Coefficient	t-statistic
Constant	-5.635	0.000
Household size (0: <= 2; 1 :3-6; 2: >= 7)	0.211	2.045
Number of working adults in a household (0: <=2; 1: 3-6; 2: >=7)	-0.299	-2.624
Weekly average traveling distance (0: ≤ 50 km; 1: 51-150 km; 2: > 151 km)	0.200	2.185
Vehicle ownership in a household (0:1; 1:2; 2:3; 3: >= 4)	-0.175	-3.300
Frequency of listening to radio per-trip (0: Never; 1: Once/month; 2: Once/week; 3: 2-5 times/week; 4: Daily)	0.226	5.922
Log likelihood at convergence $\mu_1 = 1.32, \mu_2 = 3.93, \mu_3 = 6.45$	-1702	

4.2 Perceived Accuracy

The perceived accuracy describes driver experience on how accurate is the traffic information obtained compared to the real situation. This includes the estimated travel time and level of congestion disseminated by the system. Table 3 shows the model which is significant at 95% confidence level.

Driver socio-economic attribute has little impact on the perceived accuracy. All the three major races in the country perceived that the information is less accurate. Driver travel characteristics could also affect the perceived accuracy. Drivers who have longer travel distance in average perceived that the information is accurate. This is logic as drivers who have more frequent travel have higher probability to obtain and use the traffic information provided.

In addition, the level of awareness has certain impact. Drivers perceived that traffic information obtained from radio is more accurate than those obtained from VMS. Drivers who perceive the information to be accurate would prefer to change to alternative routes rather than changing their departure time.

Table 3: Ordered logit model for drivers' perceived accuracy

Variable	Coefficient	t-statistic
Constant	6.785	7.926
Race		
Malay (0: No; 1: Yes)	-2.722	-3.277
Chinese (0: No; 1: Yes)	-2.949	-3.564
Indian (0: No; 1: Yes)	-2.843	-3.399
Weekly average traveling distance (0: ≤ 50 km; 1: 51-150 km; 2: > 151 km)	2.325	2.544
Frequency of listening to radio per-trip (0: Never; 1: Once/month; 2: Once/week; 3: 2-5 times/week; 4: Daily)	0.187	4.999
Frequency of reading VMS messages (0: Never; 1: Rarely; 2: Occasionally; 3: Every time)	-0.107	-2.343
Departure time change (0: No; 1: Yes)	-0.373	-9.470
Route choice change (0: No; 1: Yes)	0.155	4.045
Restricted log likelihood	-1792.0	
Log likelihood at convergence	-1700.0	
$\mu_1 = 2.25, \mu_2 = 4.73, \mu_3 = 7.64$		

4.3 Perceived Reliability

The perceived reliability describes the trust of the drivers on the information obtained from the ITIS. This could affect their level of utilization of the information obtained. Table 4 shows the ordered logit model for the perceived reliability which is significant at 95% confidence level. Drivers' socio-economic characteristics have certain impact on the perceived reliability. It is found that male drivers perceived the information more reliable compared to female drivers. The three major races, i.e. Malay, Chinese, and Indian, in the country perceived the information as less reliable.

Besides, drivers with lesser number of vehicles in the household perceived the information more reliable. This shows that drivers appreciate the information disseminated for better trip planning in the case of car sharing. Besides, drivers

perceived that traffic information disseminated via internet and radio is reliable. Nevertheless, drivers who used to utilise ITIS information comment that the traffic information is less reliable.

Table 4: Ordered logit model for drivers' perceived reliability

Variable	Coefficient	t-statistic
Constant	6.358	7.398
Gender (0: Male; 1: Female)	-0.248	-2.466
Race **Malay (0: No; 1: Yes)** **Chinese (0: No; 1: Yes)** **Indian (0: No; 1: Yes)**	 -1.652 -1.669 -1.958	 -1.992 -2.024 -2.346
Vehicle ownership in a household (0:1; 1:2; 2:3; 3: >= 4)	-0.162	-2.990
Frequency of listening to radio per-trip (0: Never; 1: Once/month; 2: Once/week; 3: 2-5 times/week; 4: Daily)	0.163	4.332
Frequency of visiting ITIS Portal (0: Never; 1: Once/month; 2: Once/week, 3: 2-5 times/week; 4: Daily)	0.345	3.355
Departure time change (0: No; 1: Yes)	-0.157	-4.184
Route choice change (0: No; 1: Yes)	-0.123	-3.236
Restricted log likelihood **Log likelihood at convergence** $\mu_1 = 1.72$, $\mu_2 = 4.28$, $\mu_3 = 7.25$	-1741.2 -1705.7	

4.4 Perceived Satisfaction

Drivers are asked whether the current system conforms to their expectation and whether they satisfy about it. They are asked to comment whether further improvement is required for the system. Table 5 shows the ordered logit model for the perceived reliability which is significant at 95% confidence level. Household with low vehicle ownership and more working adults perceived higher level of satisfaction. This shows that drivers appreciate the information disseminated for better trip planning in the case of car sharing. Drivers who have shorter travel distance in a week perceived more satisfy to the system. This shows that they appreciate the system well for their travel planning.

Furthermore, drivers perceived satisfactory on the information disseminated via internet and radio. Drivers who satisfied with the system choose to change their departure time choice rather than route choice.

4.5 Perceived Travel Time Saving

This is to investigate whether drivers perceive that the traffic information obtained could help them save their travel time by making necessary adjustment to their trip. Table 6 shows the model which is significant at 95% confidence level. Females and those household with fewer vehicle ownership perceived positively towards the benefit of ITIS in travel time saving. Among the ITIS tools, drivers perceived that they could obtain valuable traffic information from radio.

In addition, drivers perceived that they could save travel time by changing their departure time rather than diverting to alternative routes. This explains that drivers feel unsecure in choosing alternative routes in which they are unfamiliar with.

Table 5: Ordered logit model for drivers' perceived satisfaction

Variable	Coefficient	t-statistic
Constant	3.881	4.423
Age (0: 18-27; 1: 29-38; 2: 39-47; 3: 48-57; 4: > 57)	-0.132	-2.475
Vehicle ownership in a household (0:1; 1:2; 2:3; 3: >= 4)	-0.204	-4.004
Number of working adults in a household (0: <= 2; 1: 3-6; 2: >= 7)	0.256	2.271
Weekly average traveling distance (0: ≤ 50 km; 1: 51-150 km; 2: > 151 km)	-0.228	-2.534
Frequency of visiting ITIS Portal (0: Never; 1: Once/month; 2: Once/week; 3: 2-5 times/week; 4: Daily)	0.298	3.204
Frequency of listening to radio per-trip (0: Never; 1: Once/month; 2: Once/week; 3: 2-5 times/week; 4: Daily)	0.224	6.093
Departure time change (0: No; 1: Yes)	0.252	6.583
Route choice change (0: No; 1: Yes)	-0.314	-8.144
Restricted log likelihood **Log likelihood at convergence** $\mu_1 = 1.88$, $\mu_2 = 3.79$, $\mu_3 = 5.95$	-2063.2 -1987.6	

In addition, they are uncertain on the traffic situation on the alternative routes.

Table 6: Ordered logit model for drivers' perceived travel time saving

Variable	Coefficient	t-statistic
Constant	3.415	4.304
Gender (0: Male; 1: Female)	0.229	2.334
Vehicle ownership in a household (0:1; 1:2; 2:3; 3: >= 4)	-0.225	-4.322
Frequency of listening to radio per-trip (0: Never; 1: Once/month; 2: Once/week; 3: 2-5 times/week; 4: Daily)	0.181	4.805
Departure time change (0: No; 1: Yes)	0.203	5.328
Route choice change (0: No; 1: Yes)	-0.083	-2.180
Restricted log likelihood **Log likelihood at convergence** $\mu_1 = 2.24$, $\mu_2 = 4.16$, $\mu_3 = 7.21$	-1839.5 -1792.3	

5.0 COMMENTS ON DRIVER PERCEIVED EFFECTIVENESS OF ITIS

From the models presented above, there are a few interesting results obtained. First, it is observed that the socio-economic background of the drivers has little influence on their perceived effectiveness of ITIS. Youngsters are more satisfy with the system while all three main races in the country perceived that the information is less accurate. Drivers who have lower number

of vehicle ownership in the household are desperately required more traffic information for their trip planning purposes due to car sharing with partners. Second, drivers who travel longer distance in average appreciate the deployment of the system. They perceived that ITIS is useful and the information delivered has high level of accuracy. Nonetheless, most of them think that there is still much room of improvement to the current system, such as to increase the information coverage area, and types of information disseminated. Third, radio is an important tool that can influence drivers' behavior especially before they start a trip. Drivers have great acknowledgement to the traffic information delivered through radio. They trust the information to be useful, accurate, reliable, and could help them save their travel time. In overall, they feel satisfied with radio. Besides, drivers perceived that the traffic information on ITIS Portal is reliable. They feel satisfy to the ITIS Portal, in terms of website user-friendliness, loading speed and easy understandable. The three major purposes of them visiting the website are to use the Journey Planner (42%) in order to find the best route for traveling, followed by viewing the Road Congestion Map to obtain updated traffic condition (19%), and to view the real time traffic via video streaming (18%). When asked the reasons why they did not visit the website, the main reason cited is unaware of its existence (70%). Respondents perceived that the information from VMS is inaccurate (25%), despite that VMS is a popular tool favored by drivers [11]. Forth, drivers prefer to adjust their departure time choice (either earlier or later) than changing to alternative routes. The adjusting rate for departure time choice and route choice are 26% and 24% respectively [11]. They chose to change their departure time if they are satisfied with the system and perceived that it could save their travel time. 74% of the respondents choose to change their departure time when they receive traffic information of heavy traffic condition, while the major reason cited for not changing is due to fixed arrival time (44%). They considered diverting to alternative routes if they perceived that the information as accurate. About 73% of the respondents are willing to divert to alternative routes if heavy traffic condition is reported. The three main factors that discourage them to do so are such as unconvinced of the traffic condition on the alternative roads (31%), tolls on alternative roads (15%), and lack of knowledge on network background (11%).

It could be seen that there is some relation among drivers' perceived effectiveness, level of awareness and level of utilisation. However, they are not necessarily positively or negatively related. Drivers would prefer to obtain the information from certain tool but not necessary perceived it to be the most effective one. In this case, VMS is the most popular tool preferred by drivers [11] but they perceived radio as the most effective tool. According to the drivers' post-experience on utilising the ITIS information, they commented that the information provided is less accurate and less reliable. In addition, the findings obtained in this study also show that the effectiveness of the ITIS could not be represented by the awareness of one type of tool or one type of response measured. Drivers might perceive some tools as inaccurate (VMS in this case) but have high recommendation on the other tool (radio in this case). Moreover, drivers might perceive the system as useful but reluctant to make changes to their trip due to some external effects. Thus, one should consider the performance of the overall system rather than a single component in measuring the effectiveness of the ITIS.

6.0 CONCLUSION

This paper has investigated the driver perceived effectiveness of the implementation of ITIS system in Klang Valley region, Malaysia. The perceived effectiveness is evaluated through five important performance indicators, namely usefulness, reliability, satisfaction, accuracy, and the benefit of travel time saving. A total of 1506 qualified drivers are interviewed. It is found that about 56% of the drivers perceived that the ITIS is useful and important for their trip planning, but only 17.9% of them satisfied with the current system. This means that ITIS has the potential to help in alleviating traffic congestion problem if the current system can be further improved. Besides, it is observed that drivers perceived negatively on the accuracy and the reliability of the system. This indicates that the current system has limitations and needs to be improved. Besides, drivers prefer to obtain traffic information from various tools of ITIS, as they perceived the effectiveness of these tools differently. They like to listen to radio for information, but have higher perceived reliability to information disseminated by internet (ITIS Portal). They might complaint that the information disseminated via VMS is less accurate but willing to pay more attention to its information. These findings indicate the complexity of driver perception and behavior to the ITIS system.

To improve the effectiveness of the current system, the authority could consider to extent their system by developing a dedicated radio channel specifically for traffic information dissemination purposes. Besides, the coverage area of the ITIS could be extended to some other roads in the region. It would be better if the advice on the alternative roads could be delivered to drivers traveling on the congested roads. On the other hand, the authority should consider seriously on the types of the message delivered through VMS. This is the concern with the dynamic traffic assignment in which whether actual or ideal route travel time should be provided. Some research studies are required in the future to look into this matter. The limitation of the current study is the uneven distribution of the respondents interviewed. It is observed that more than half of the respondents are youngsters (58%) and Chinese (56%). This could be a source of bias to the results obtained.

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PROFILE

ENGR. DR KHOO HOO LING obtained her PhD from the National University of Singapore in 2008. She has a Master of Engineering Science and Bachelor of Civil Engineering from Universiti Malaya in 2005 and 2002 respectively. She is currently an Assistance Professor in the Universiti Tunku Abdul Rahman (UTAR). Her research interests are in traffic modelling and simulation, transportation network design, traffic safety and sustainable transportation. She has numerous publications in the international and regional journals and is currently the Head of Department of Civil Engineering in UTAR since 2009.