International Journal of Technology (2016) 4: 553-561
ISSN 2086-9614

THE IMPACT OF INTELLIGENT TRANSPORT SYSTEM QUALITY: DRIVERS' ACCEPTANCE PERSPECTIVE

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(Received: November 2015 / Revised: April 2016 / Accepted: April 2016)

ABSTRACT

An effective and real-time traffic information network is highly important and could contribute to decreasing traffic volume and costs by reducing fuel consumption and saving time for drivers in reaching their destinations. This study provides an extensive analysis regarding the drivers' acceptance levels of the current implementation of the Intelligent Transport System (ITS) in Kuala Lumpur. A proposed model from the literature review based on the known Technology Acceptance Model (TAM) is introduced. The ITS system characteristics, information quality, system quality, and service quality were investigated as external variables. The resulting analysis showed that information quality is the highest influential factor followed by system quality. The results also revealed that service quality had no effect on acceptance levels.

Keywords: Car drivers; Congestion; ITS; Kuala Lumpur; TAM

1. INTRODUCTION

An effective traffic information system is highly important and could contribute to creating a balance between the different modes of transport, such as pedestrians, bicycles, motorcycles, vehicles, and public transport. In addition, it could provide security, safety, and optimum service for public roadways and ensure the continuance of mobility, which drives economic development through timely and convenient transportation (Khoo & Ong, 2012).

Long-term solutions such as upgrading public transport systems and introducing city center road toll systems may not be sufficient in reducing traffic jams and preventing congestion by distributing traffic onto different roadways while still reaching the same destination. Therefore, the need for high-quality information in real-time through high-performance traffic management systems can be crucial to the success of city planning and transportation policies (Bergerbow & Kate, 2002).

Two of the primary advantages of using quality and accurate real-time information to manage road traffic and to notify drivers before routing to a congested roadway are reducing fuel consumption and saving time, which save cost and reduce pollution as well. For example, congestion in various parts of Japan due to the increase in vehicle traffic causes a time loss of 5.3 billion hours annually, which corresponds to an economic loss of JPY 12 trillion. In addition, almost 10,000 people are killed in traffic accidents annually. Moreover, vehicle traffic causes considerable harm to the environment and to the economy (Lwasaki et al., 2004).

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Permalink/DOI: http://dx.doi.org/10.14716/ijtech.v7i4.2578

In this study, it is argued that the migration of people from rural to urbanized habitats has progressed differently in many developing countries in Asia, especially in the Far East Asian countries, because of the rapid economic development in last two decades. Many areas have urbanized without significant planning for future congestion on the roads or forecasting for the increased rate of vehicles. A study conducted by Dargay et al. (2007) showed the historical growth rates in vehicle ownership and per-capita income (1970-2002) as well as the projected growth rates for the years 2002-2030. The historical results for 1970-2002 showed that vehicle ownership in Malaysia grew twice as fast as per-capita income. The projected results for 2030 showed that Malaysia will experience growth in vehicle ownership that will be at least as rapid as its growth in per-capita income. GDP per capita has increased tremendously from USD 1779 in 1980 to USD 10052 in 2013 (Department of Statistics, Malaysia, 2014). This proves that Malaysia is a developing country that is emerging market economy in which the population of its people has increased, and at the same time, the demand for travel has increased. This has resulted in an increasing demand for the use of private vehicles and car ownership. Private vehicles also produce a considerable amount of air pollution, pose a significant safety risk, and exacerbate feelings of inequities in the society. The increasingly active car use in and around the cities in industrialized countries has led to increased accessibility problems, which is reflected in traffic jams and parking issues. In addition to road congestion, private vehicles also cause serious problems, such as CO_2 pollution, global warming, and noise (Abrahamse et al., 2010; Buehler 2010).

There is a need for a new traffic management approach that provides real-time information and establishes a network for traffic status and control on the roadways, and the traffic information should reach all subscribers in the network in real-time and should be characterized by high quality and accuracy. Therefore, Japan and European countries such as Germany and the UK have innovated and deployed Intelligent Transport Systems (ITS) to reduce traffic volume and congestion (Hauschild, 2003).

ITS is an advanced application that aims to provide innovative services related to different modes of transport and traffic management and to enable various users and vehicle drivers to be better informed and make safer, more coordinated, and "smarter" use of transport networks. ITS systems provide information and communication technologies in the field of road transport, including infrastructure, vehicles, and users, and in traffic management and mobility management as well as for interfaces with other modes of transport (Tarnoff, 2002).

Drivers are able to access a variety of information sources in the vehicle whether they are on or off the roadways. One of the most efficient information sources is route guidance with current traffic congestion messages, and most drivers in Malaysia are familiar and have experience in avoiding traffic jams; however, their experience might not be sufficient in avoiding traffic jams because in many cases, their alternative routes may also be congested. Human experience may be both positive and negative; therefore, drivers on Malaysian roads need efficient traffic information in real-time to be informed through large displays on the road or messages sent to cell phones or GPS devices affixed inside vehicles.

Typically, an ITS includes traveler information in the form of travel times posted on Variable Message Signs (VMS) on major roads to help drivers make more informed decisions about their travel route options. Traveler information, such as travel times, is dependent both on the quality of the prediction algorithms and on the quality of the data cleaning applied to the data used by the prediction algorithms (Megler et al., 2016).

Therefore, the goal of the present study was to contribute one step to the process of adopting a modern ITS in Malaysia. Evaluating the drivers' acceptance level of the current system and analyzing the factors that affect the acceptance level will be crucial in the upcoming revised ITS system. ITS is expected to help resolve intractable problems associated with road congestion in Malaysia by eliminating the amount of time people spend in traffic jams producing exhaust fuel and gases. In this study, an extended version of the Technology Acceptance Model (TAM) theory was used to predict the acceptance level of the current ITS system in Kuala Lumpur, Malaysia.

1.1. Technology Acceptance Model

The technology acceptance model (TAM) was developed by Davis (1989) and is one of the most widely used models in the study of information technology because it is simple and easy to apply. TAM is a model used to explain how users accept and use a specific technology (e.g., ITS). According to TAM, one's actual use of technology system is influenced directly or indirectly by the user's behavioral intentions, attitude, perceived usefulness of the system, and perceived ease of the system.

A major step in measuring acceptance was done by Van der Laan et al. (1997), who suggested a standardized procedure to measure two dimensions of acceptance of advanced transport telematics: "usefulness" and "satisfaction." This method makes it possible to quickly estimate the usefulness and satisfaction of a system and to compare different systems; however, it has not been shown that the constructs "usefulness" and "satisfaction" influence the acceptance and use of a system. Furthermore, the method is limited to two dimensions of the acceptance construct. The literature both within the traffic safety area and in other areas, such as information technology, suggests that acceptance is of a more complex nature and could also contain dimensions such as social influence, effectiveness, and perceived value (see for example NHTSA 2006, Venkatesh et al., 2003).

The present situation in Malaysia, which lacks both a definition of acceptance and a framework in which the acceptance could be viewed, makes it difficult to understand the level of acceptance or to learn how to improve the acceptance. Making comparisons between systems and studies is almost impossible. A definition and a model in which viewing acceptance would contribute more information to the knowledge base of the concept of acceptance and the driving factors are needed. This could provide valuable information in the development, design, deployment, and implementation of new driver support systems.

User acceptance of information systems has received fairly extensive attention in information systems research. For empirical studies on the user acceptance of information systems, theoretical frameworks for user acceptance in the implementation of the systems have been developed to help researchers and practitioners better understand the adoption and usage processes. Studies that propose theoretical frameworks and provide empirical findings for the respective theoretical framework have become more common (Ajzen & Fishbein, 1980; Davis et al., 1989; Mathieson, 1991; Thompson et al., 1991). Among the models, TAM has been recognized as the most robust, parsimonious, and influential

1.2. Research Model and Hypotheses

The model for the current study was based on the original TAM as extended by Moon and Kim (2001) and Ahn et al. (2007). It included three system quality characteristic constructs for ITS (system, information, and service quality) as antecedents of user beliefs. Figure 1 shows our research model, which was an extension of TAM because it included ITS system quality characteristics.

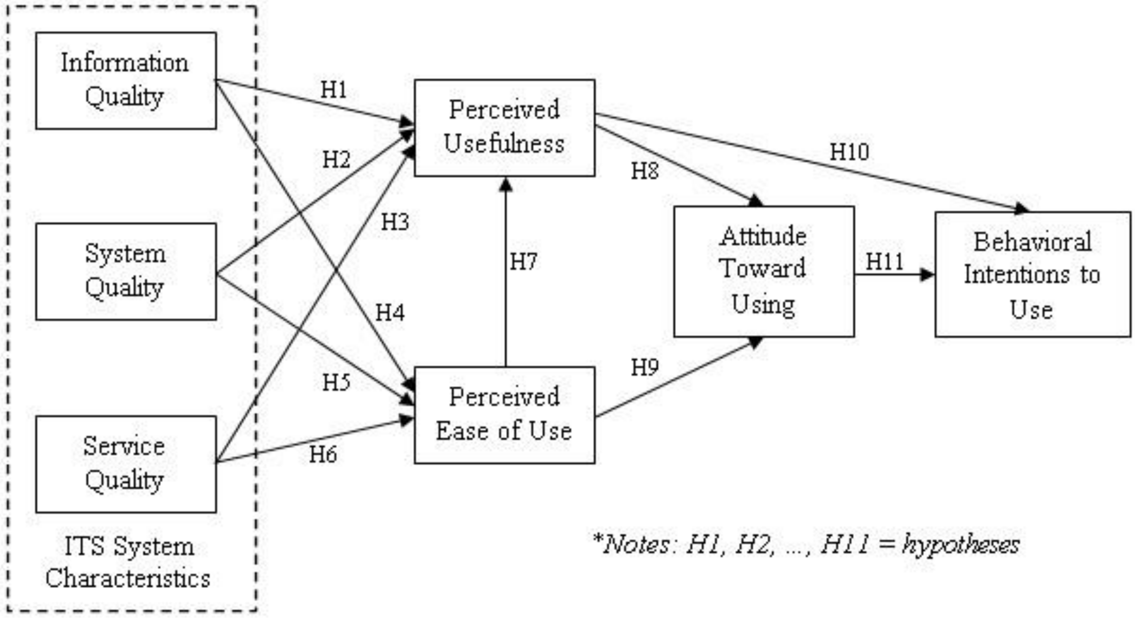

Figure 1 The proposed model

Information quality and system quality are two important ITS system characteristics in the context of ITS system success (Delone & Mclean, 1992; Wang, 2008). A previous study on traveller information system operators and users indicated that providing travelers with timely, accurate, reliable, and relevant information is necessary to satisfy their needs when making travel decisions (Jelusic, 2010). Another evaluation of ITS deployment also identified the quality of traveller information as a critical determinant of traveller information use (Jensen et al., 2000). Chorus et al. (2006) summarized studies on ITS use and determined that information quality is essential to traveller information use. In addition, a considerable amount of multimedia traveller information used on web pages may lead to longer download times than on other general websites. Slow response times may cause users to lose patience with the service involved and consequently to visit the site less frequently or to avoid it completely. Therefore, in this study, the role of information quality, system quality, and service quality on travelers' likelihood to adopt a web-based ITS was examined. Thus, we hypothesized the following:

Hypothesis 1: Information Quality characteristics positively affect Perceived Usefulness
Hypothesis 2: System Quality characteristics positively affect Perceived Usefulness
Hypothesis 3: Service Quality characteristics positively affect Perceived Usefulness
Hypothesis 4: Information Quality characteristics positively affect Perceived Ease of Use
Hypothesis 5: System Quality characteristics positively affect Perceived Ease of Use
Hypothesis 6: Service Quality characteristics positively affect Perceived Ease of Use
Hypothesis 7: Perceived Ease of Use characteristics positively affect Perceived Usefulness
Hypothesis 8: Perceived Usefulness characteristics positively affect Attitude towards Use
Hypothesis 9: Perceived Ease of Use characteristics positively affect Attitude towards Use
Hypothesis 10: Perceived Usefulness characteristics positively affect Intention to Use
Hypothesis 11: Attitude towards Use characteristics positively affect Intention to Use

2. METHODOLOGY

2.1. Sample and Data Collection

The data collection from the respondents was conducted through questionnaires distributed to vehicle drivers in Kuala Lumpur. The majority of the respondents who participated in this study were private vehicle drivers. In this study, a stratified sampling method was used in the approach to obtain a sample of respondents. In the stratified sampling method, the population is divided into sub-populations called strata. Then, the sample is selected from these strata. The overall sample was collected from this strata, known as the stratified random sampling method. Therefore, employees who used private vehicles as their main mode of transportation in Kuala Lumpur were chosen. A total of 300 self-administered questionnaires were distributed throughout the data collection period. Only 281 questionnaires were considered for further action in which 19 forms were rejected as invalid. A total of 200 questionnaires were used for model calibrations, and 81 were used for validation.

2.2. Measurement Development

The questionnaires were designed to collect the required information from the respondents for research purposes. The questionnaire was divided into three main aspects, which is a modification of the questionnaires used in previous studies. The subjects included in the questionnaire were as follows:

a) Part A: Background of respondents
b) Part B: Information on respondents’ travel
c) Part C: Information based on the conceptual model

Translation was carried out to ensure consistency between the Malaysian language and the original language of the instrument. Items from the previous studies were translated from English to Malaysian by two professors from engineering and social sciences schools. The items used for attitudes, perceived usefulness, perceived ease of use, and the intention construct were adapted from Moon and Kim (2001). The information quality, system quality, and service quality scales were adopted from Ahn et al. (2007). Before the main survey, a pilot test of the survey instrument was conducted to ensure that the questionnaire was acceptable and easy to answer for a wide range of respondents. The pilot test of 30 samples of respondents was conducted to receive information and feedback from the questionnaires. Overall, the respondents understood the questions on the questionnaire form; however, there was some confusion. Based on the recommendations from respondents, questions that were not clear were re-worded. The pilot test was conducted again to ensure that the questions on the questionnaire form were completely understood by the respondents. Based on the responses received, the respondents were able to understand the requirements of the questions on the questionnaire form. For the measurement scale of the questionnaire, Section C of the questions based on the TAM adopted the 5-point Likert scale with 1 = Strongly Disagree to 5 = Strongly Agree.

3. RESULTS

The respondents consisted primarily of car drivers who were in the mean age group of 18-30 years old, which accounted for 43.6%. In addition, 31.5% of respondents were aged 31-40 years old, 21.5% of respondents were aged 41-50 years old, and 3.3% were over 50 years of age. Regarding gender, the sample was 84% male and 16% female. Respondents had different levels of driving experience in terms of the number of years they had been driving. For instance, 40.9% of drivers had 11-20 years of experience, while 37% had 5-10 years of experience. The remaining 19.3% of the respondents had less than 5 years of driving experience. The remaining of 2.8% were experts with more than 20 years of driving experience.

Table 1 shows the correlation analysis for all variables used in this study. A correlation is a measurement that reveals the strength of the linear relationship between two variables. For example, a correlation between the behavioral intention to use ITS and the attitude towards using ITS (β = 0.360, p <0.01) had a positive linear correlation, which means that when the attitude towards using ITS increased, the behavioral intention to use ITS also increased in a linear fashion. Table 1 shows that all six variables were significantly positively correlated with behavioral intention. In addition, in this study, the reliability of scales was measured using Cronbach's α based on the internal consistency of the items in each scale. In Nunnally's (1978) guideline, a scale reliability of 0.70 and above is preferred. The Cronbach's alpha value obtained for almost all constructs demonstrated that the values exceeded the minimum value of 0.7.

Table 1 Correlation and reliability analysis

Variable	1	2	3	4	5	6	7	Cronbach's α
1-Behavioral intention to use	1							0.803
2-Attitude toward using	.360**	1						0.748
3-Perceived usefulness	.438**	.436**	1					0.790
4-Perceived ease of use	.340**	.307**	.644**	1				0.757
5-Information quality	.626**	.887**	.527**	.412**	1			0.750
6-System quality	.782**	.495**	.497**	.367**	.672**	1		0.726
7-Service quality	.151*	.160*	.161*	.167*	.144*	.136**	1	0.711

Note: *$p<0.05$; **$p<0.01$

3.1. Hypotheses Testing

Hypotheses 1, 2, 3, and 7 examined the relationship between ITS system characteristics and perceived ease of use with perceived usefulness. Perceived ease of use (β = 0.192, p <0.01), information quality (β = 0.346, p <0.001), and system quality (β = 0.253, p <0.01) were significantly related to perceived usefulness; however, service quality had no significant relationship with perceived usefulness. Therefore, hypotheses 1, 2, and 7 were not rejected, but hypothesis 3 was rejected. Similarly, hypotheses 4, 5, and 6 examined the relationships between ITS system characteristics and perceived ease of use. Information quality (β = 0.294, p <0.001) and system quality (β = 0.154, p <0.05) had a significant effect on perceived ease of use. Conversely, service quality was not significantly related to perceived ease of use. Therefore, hypotheses 4 and 5 were not rejected, but hypothesis 6 was rejected. In hypotheses 8 and 9, we examined the effects of individual perceptions, perceived usefulness, and perceived ease of use of ITS on the attitude towards using ITS. The results showed that only perceived usefulness (β = 0.407, p <0.001) had a positive significant relationship with attitude towards using ITS, but perceived ease of use did not indicate a significant relationship with attitude towards use. Thus, hypothesis 8 was not rejected, and hypothesis 9 was rejected. For hypotheses 10 and 11, we investigated the influence of attitude and perceived usefulness on the behavioral intention to use ITS. As a result, attitude (β = 0.209, p <0.001) and perceived usefulness (β = 0.347, p <0.01) had positive and significant effects on the behavioral intention towards ITS use. Thus, neither of these relationships were rejected for hypotheses 10 and 11. A summary of the hypotheses testing model is shown in Table 2.

Table 2 Results of hypotheses tests

Dependent Variable	β	R^2	Adj. R^2	p-Values	Hypothesis result
DV Behavioral intention to use		0.227	0.219	<0.001	
Attitude toward using	0.209			<0.001	H11 was accepted
Perceived usefulness	0.347			<0.01	H10 was accepted
DV Attitude toward using		0.191	0.182	<0.001	
Perceived usefulness	0.407			<0.001	H8 was accepted
Perceived ease of use	0.045			N.S	H9 was rejected
DV Perceived usefulness		0.320	0.309	<0.001	
Perceived ease of use	0.192			<0.01	H7 was accepted
Information quality	0.346			<0.001	H1 was accepted
System quality	0.253			<0.01	H2 was accepted
Service quality	0.078			N.S	H3 was rejected
DV Perceived ease of use		0.195	0.182	<0.001	
Information quality	0.294			<0.001	H4 was accepted
System quality	0.154			<0.05	H5 was accepted
Service quality	0.105			N.S	H6 was rejected

Note: *DV = dependent variable; N.S = Not significant*

4. DISCUSSION

Malaysia has successfully begun to adopt ITS for the main roadways of Kuala Lumpur, and the government and the public intend to be on the same level as other Asian countries, such as Japan and China (Xiong et al., 2012), who have developed a considerably advanced application for traffic management and have adopted communication and information technologies to decrease one of its most obstinate problems—traffic congestion.

The results show that among the three ITS system characteristics, service quality had no impact on drivers' acceptance, while information quality is a major influential factor followed by system quality. Service quality can be ignored; however, both information quality and system quality are important influential factors. The importance of timely and sufficient information indicates that developers should consider this to be a crucial factor when developing the system. The availability of information and fast updates are vital for system use, and developers must take that into consideration as well. Therefore, the officials who are in charge of the implementation of ITS in Malaysia should pay more attention to the information quality of real-time data. Current high-tech wired (e.g., fiber optic) and wireless (e.g., FM radio, satellite, cellular) communication should be applied for broadcasting information, such as traffic information (Fang et al., 2010; Mai et al., 2012). Doing so will help drivers change their routes when better alternatives are available, and the overall outcome would be less traffic congestion and a high efficiency of traffic management in Malaysia.

The findings also support TAM, and the relationships in the model proved that perceived usefulness and attitude of use are mediating processes in reaching acceptance, which is represented by intention to use. The findings are similar to those reported by Ahn et al. (2007), Chen et al. (2007), and Moon and Kim (2001). This study also showed a significant effect of two factors (information quality and system quality) on the usefulness and acceptance of the intelligence transport system in the city of Kuala Lumpur, though service quality did not show a significant effect. These findings are in line with theories that assume that information quality and system quality are two important ITS characteristics in the context of ITS success (Delone & Mclean, 1992; Wang, 2008). A previous study on traveller information system operators and users indicated that providing travelers with timely, accurate, reliable, and relevant information is necessary to satisfy their needs when making travel decisions (Jelusic et al., 2010).

Lastly, perceived ease of use for ITS appeared to have no significant effect on the attitude towards using ITS. A plausible explanation is that perceived ease of use might often indicate its influence on attitude through the mediator of perceived usefulness. In other words, the users would need to take a period of time to adopt ITS whether or not the technology fulfills their service needs. Thus, ITS is acceptable only when demonstrating proven or desired utility in its practices.

5. CONCLUSION

The objectives of this study were to identify the factors and dimensions that may affect the drivers' acceptance of the ITS system in Kuala Lumpur. These objectives were achieved by introducing the proposed model, which resulted from the literature review (based on the original TAM as extended by Moon and Kim (2001) and Ahn et al. (2007)). The model was mainly developed based on the well-known TAM model, and external variables related to information systems were added. The ITS system characteristics, information quality, system quality, and service quality were investigated as external variables in the extension of TAM. Our research model was well supported, and most of the hypotheses were supported. This study provides beneficial insights into a model that predicts vehicle users' behavioral intentions to accept ITS. The resulting analysis showed that information quality is the highest influential factor followed by system quality. It was also found that service quality had no effect on the acceptance level. Future work is recommended to investigate additional variables that may affect acceptance.

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