

Applications of Green Technology for Sustainable Public Bus Services

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ABSTRACT: Reduced carbon footprints and sustainable public transportation including bus services can be achieved with the applications of suitable green technology. However, to promote the usage of green technology, the technology must not only meet public needs but the public must also appreciate the benefits of adopting green technology in the form of ICT solutions in their routines. Using a theoretical model based on the theory of Technology Acceptance Model (TAM), this study determines the needs for prompt delivery from bus operators as one of the most important modes of public transportation and to develop the appropriate technology applications that would best fulfil these needs. Twenty five bus drivers and users from the state of Malacca were surveyed on their perceptions of existing services as well as suggestions for actions to improve the services. Potential characteristics of green technology for meeting these needs were also identified which will be used for the development of the new technology. Initial findings from this research indicate that ascertaining availability of bus is an issue that can be alleviated by appropriate applications. Important attributes of the ICT solution identified included ease of payment and ease of use.

1 INTRODUCTION

Malaysian aspires to be a high income nation by the year 2020 and emphasizes sustainability development as one of its core values. Thus, green technology has been identified as one of the key elements in the process of achieving the high income goal status. To spearhead the achievement of the vision, the Ministry of Energy, Water and Communications was established in March 2004 (which was later renamed as Ministry of Energy, Green Technology and Water in April 2009) formulated the National Green Technology Policy (NGTP) that provides national guidelines to improve the four (4) key sectors namely, energy, buildings, water & waste water management and transportation.

Meanwhile, the existing New Economic Model has established sustainability as one of the three goals of the economic transformation programs and aspires to place Malaysia as a green hub all the way along the business development continuum; from research to design to manufacturing to commercialization. The Ministry of Energy, Green Technology and Water has elaborated on the vision for the energy sector for 2020, which stipulates that by the year 2020, every member of Malaysian society should have access to high quality, secure electrical power and other convenient forms of energy supplied in a

sustainable, efficient and cost-effective manner, and to use them efficiently and responsibly to propel economic activities and maintain a high quality of life, having regard to the need to minimize the negative impacts of their supply and use on the environment (Ministry of Energy, Green Technology and Water, 2013).

To ensure proper planning, regulating and enforcement of public land transportation related matters and operations, The Land Public Transport Commission (SPAD), was established in June 2010 and began operations in September 2012 (SPAD, 2012). It is also be responsible for providing guidelines that lead to safe and reliable services public transport at reasonable fares to encourage more people to use public transport (Tenth Malaysia Plan, 2010). The establishment of SPAD support the high income nation agenda as public transportation is related to high productivity; a key factor in the high income nation agenda. Efficient public transportation encourages the use of public transportation; discourage the use of private transportation leading to reduced traffic congestion (Kamaruddin et al., 2012). Public transportation thus, should become the preferred services for the people of Malaysia in the urban area, as one of the effort to support the sustainable environment.

However, as it is now, public transportation is not the preferred choice for commuters in Malaysia as

compared to other developed countries. For example, a typical urban area such as the Klang Valley records only 17% of public transport users in 2010 compared to around 60% in Singapore and 89% in Hong Kong (Yaakub and Napiyah, 2011). The low usage of public transportation according to Yaakub and Napiyah (2011) is due to the fact that public transportation system in Malaysia is still below the standard of other developed countries and thus is unsatisfactory in meeting public needs. These figures indicate improvement is needed in some aspects of management and implementation of public transport services in Malaysia.

Malaysia recognizes the need to upgrade the existing public transportation services nationwide and by creating more reliable, efficient and integrated public transportation system and has taken appropriate measures towards it (Tenth Malaysia Plan, 2010). Effective public transportation system will increase public transportation users and indirectly reduce private vehicles and their associated problems such as high accidents occurrences, traffic congestion and air pollution. Ineffective public transportation system will not only affect the economy, but also affect the environment from greenhouse gas emission. For that reason, reduced carbon footprints and sustainable public transportation including bus services is necessary and can be achieved with the applications of suitable green technology.

Previous study has proven that ICT application has significantly decreased the total number of trips made by users (Wang and Law, 2007). Thus, ICT system can be applied to increase the effectiveness of management and implementation of public transportations system, especially bus services. Past study also indicate that public transportation will be the preferred choice of commuters if it is efficient as commuters can avoid from paying high petrol prices and tolls and being stuck in traffic jams when using private transport (Kambala, et al., 2007). Therefore, the purpose of this study is to seek greater understanding of the public transportation issues and potential green technology solutions. The specific objectives are to identify needs of public related to public bus services, to identify attributes of the green technology that may fulfill the needs of public (operators, drivers and users), and to determine public awareness of green technology.

2 METHODOLOGY

2.1 Research design

The survey design was used in this study, as it can be used to make descriptive assertions about large population (Dantzker and Hunter, 2012). A random sample of 25 bus drivers and users in Malacca were surveyed on their perceptions of existing services and possible steps to be undertaken to improve the

services. Melaka was selected as the location of study as Melaka is a tourist state which is expected to benefit most from immediate establishment of efficient public transport.

Potential characteristics of green technology for meeting these needs were also identified which will be used for the development of the new technology. To strengthen the findings, interview was conducted to support the quantitative data. Of all participants, nine drivers and 10 users were randomly selected for semi-structured interview. All the drivers are male participants aged ranges from 32 to 59 years old, while eight female and two male users aged range from 16 to 25 years old.

2.2 Instruments

The study uses questionnaire for data collection, which comprises of three parts: Part A = satisfaction of bus services, Part B = intention to use a green technology, and Part C = public awareness of green technology. In part B and C, the Technology Acceptance Model (TAM) was used to guide the researchers in the identifications of green technology attributes to increase users' acceptance of the yet to-be-developed technology. Based on TAM, two components are crucial in influencing users' intention to use a new technology namely, perceive usefulness and ease of use. Thus, the questionnaire on characteristics of green technology has two main components, perceive usefulness and ease of use. An example of item for perceived usefulness is "Driver's profile permitting consumers to choose drivers as necessary to increase passenger's safety" and an example of item for ease of use is "Can implement mode of payment online (MB2u)". Respondents are asked to give their agreements to given statements based on the five point Likert Scale, "1" for strongly disagree and "5" for strongly agree.

Instrument was tested for reliability. A high reliability coefficient indicates a highly reliable instrument. The reliability coefficient based on the Cronbach Alpha method for the instrument as a whole is 0.73, which is acceptable being above 0.6 (Perera et al., 2008). The reliability estimates for each questionnaire components are shown in Table 1:

Table 1. Cronbach Alpha reliability coefficients

Part	Reliability
A	0.63
B	0.81
C	0.61

Quantitative data from the questionnaires were analyzed using frequencies, percentage and mean scores. For the qualitative data, the interview participants were asked a series of thematic questions re-

garding the uses and satisfaction of bus services, their intention to use green technology, and awareness of green technology. The qualitative data were recorded in written formats. They were then classified according to thematic groups and arranged into matrix form.

3 RESULTS

3.1 Demography

The gender of the participants is not split equally, with 72% female and 28% male for the users. It was found that 84% (21) users using bus services at least three times for a week and 16% (4) more than seven times for a week. The highest proportion of users demonstrates that 72% using bus for a personal purpose. The next highest is using bus services to travel to work (20%). Other reasons for using bus services were including for a safe journey (36%), for on time reach destination (20%), for comfortable (12%), and for other reasons (32%) (e.g.: travel to school and to hometown). The majority of users (52%) taking a bus at the bus station while the next highest proportion is taking a bus at the roadside bus stop.

3.2 Issues related to public transportation

Means and standard deviations (SD) were used to determine issues and problems related to public transportation services. The data is based on Part A, regarding users' satisfaction of bus services. Of all respondents, 48% of users had spent more than 30 minutes waiting for a bus services. When asked regarding users' satisfaction, 48% rated low or dissatisfaction on the item "Bus service is easily available" with mean score 2.48 (SD = 1). Also, 48% perceived dissatisfaction of bus interior comfort (Mean = 3.04; SD = 1.02) and 44% perceived dissatisfaction on the punctuality of the bus services (Mean = 2.64; SD = .76). The mean scores for the other items are indicated in Table 2.

Table 2. Users satisfaction of bus services

Item	Users	
	Min	SD
Services are available on time	2.64	.76
Drivers are courteous	2.96	.89
Reasonable rate	3.40	.87
Feel secured using bus	3.08	.86
Interior comfort is satisfactory	3.04	1.02
Bus service is easily available	2.48	1.00

Based on the interview data, respondents highlighted that the bus services were usually late, as well as departs not according to the schedule. Overcrowding with passengers is another main complaint. Almost all of respondents interviewed were waiting more than 30 minutes, only few of them waiting less than

15 minutes. In regards to the matter of users' satisfaction on the bus services, seven out of 10 participants stressed their dissatisfaction. Most comments recorded were "service is not on time", "not according to schedule", "not enough seats", and "not enough bus".

Based on the interview with drivers, the participants raised issues of passengers who did not pay the cost/fare. The participants also believed that this issue is due to the conventional payment system that is using ticket. Some drivers also highlighted that they have to deal with nagging passengers.

3.3 Attributes of green technology

Eighty four percent of users of bus services perceived that the information regarding the cost and payments is useful with mean score of 4.00 (SD = .71). A very high percentage of users (92%) perceived the attribute "Proof of payment and reimbursement" as useful with a mean score of 4.16 (SD = .55) on the associated item. Also, about 84% of users perceived useful on the item "Travel map to be introduced enabling consumers to choose their travel routes" with mean score 3.96 (SD = .68). The other items were also rated useful in regards to the information of current traffic condition (Mean = 3.88; SD = .67) and the information of driver profiles (mean = 3.84; SD = .69).

For bus drivers, a high percentage of 96% of the respondents agreed that proof of payment and reimbursement is very important to have for the ICT application (Mean = 4.56; SD = .71). However, respondents perceived that the consumer's acknowledgement was less important with mean score of 1.96 (SD = .98). The details of the analysis are shown in Table 3.

Regarding perceived ease of use of ICT application, the data analysis result indicates that 82% of the users agreed that the ICT application should display information in both languages namely in Bahasa Melayu and English with the highest mean score of 4.08 (SD = .64). About 80% of users surveyed indicated their agreement on having an ICT application that is easily accessible using all types of smart phones (Mean = 3.96; SD = .73).

For bus drivers, 96% of the respondents agreed that the ICT application should display information in both languages with the highest mean score 4.24 (SD = .52). More interestingly, 96% of the bus drivers disagreed on the item "Can implement mode of payment online (e.g.maybank2u)". The details on the mean score and standard deviation on each item are shown in Table 4.

Table 3. Perceived usefulness of ICT application

Item	Users		Drivers	
	Min	SD	Min	SD
Travel map to be introduced enabling consumers to choose their travel routes	3.96	.68	3.68	1.49
Driver's profile permitting consumers to choose drivers as necessary to increase passenger's safety	3.84	.69	3.80	1.08
Current traffic conditions and related activities that can influence traffic flow, hence enabling consumers to plan their journey	3.88	.67	2.96	1.06
The cost and payment enabling consumers to plan their budget	4.00	.71	4.08	.91
Consumer's acknowledgement enabling them to plan their journey efficiently	3.76	.88	1.96	.98
Proof of payment and reimbursement	4.16	.55	4.56	.71

Table 4: Attribute of ICT application

Item	Users		Drivers	
	Min	SD	Min	SD
Consumer can register online	3.84	.94	2.64	1.22
Easily accessible using all types of smart phones	3.96	.73	3.28	1.28
Online access 24/7	3.92	.81	1.88	.93
Interface that is consumer-friendly	3.72	.74	3.52	1.00
Display both Bahasa Melayu and English	4.08	.64	4.24	.52
Can implement mode of payment online (MB2u)	3.80	.87	1.44	.71

Based on the interviews, respondents seem to favor the use of ICT applications as a solution to the public transportation issues. Examples of suggestions include “implementing touch N go and online payment system”, “introducing mobile and internet application”, and “using better website application”. Respondents among bus drivers also stressed the importance of implementing mobile application system that is aligned with the users’ identified requirements. In line with this, drivers suggested the implementation of online ticketing, a touch and go system, and online payment method.

3.4 Public awareness towards green technology

Table 4 illustrates public awareness of green technology. Of all respondents, a high 60% of the users acknowledged that green technology has been practiced in Melaka with the highest mean score 3.76 (SD = .72). The lowest mean score is 3.04 (SD =

.73) on the item “I use green technology in my daily routine”.

For bus drivers, ninety-six percent of the respondents are interested in green technology (Mean = 4.56; SD = .58) and 92% acknowledge that green technology is used in Melaka (Mean = 4.40; SD = .65). Similar to bus users, the lowest mean score was on the item “I use green technology in my daily routine” with mean score 3.12 (SD = .78). Further descriptive statistics are shown in Table 5.

Table 5. Public awareness on green technology

Item	Users		Drivers	
	Min	SD	Min	SD
I understand the meaning of green technology	3.52	.82	4.04	.89
I understand the purpose of using green technology	3.64	.70	3.84	.90
I know that Malacca practices green technology	3.76	.72	4.40	.65
I am interested in green technology	3.44	1.04	4.56	.58
I use green technology in my daily routine	3.04	.73	3.12	.78
Green technology improves the quality of work life	3.48	.82	3.96	1.06

Based on the qualitative data, users’ suggestions on ways and means of using green technology include “using website application”, “using mobile internet application”, and “implementing touch N go and online payment system”. Suggestion from bus drivers include several ways of green technology practices such as, “applying online ticketing system”, “applying mobile, touch N go, and online payment system”, and “the application of mobile system”. Suggestions from bus drivers also include the uses of Natural Gas Vehicle (NGV) for green technology.

4 DISCUSSION

Dealing with public transport services, users’ satisfaction is one of the main concerns to be achieved by providers. In this study, users voiced dissatisfaction towards bus services in the state of Melaka. Amongst the main issues raised is the punctuality of the bus services, which is not according to the schedule. The data indicate that services on time (punctuality) are the most frequently cited concern raised by users. These include the time for waiting a bus, and availability of services, which has caused difficulty to users to catch a bus at the bus station or at the roadside bus stop. This finding is similar to the findings in previous studies on bus services in other metropolitan city of developing country. For example, the Istanbul’s Metrobus System in Istanbul city only recorded a moderate users’ satisfaction (Yazici et al., 2013). Major complaints from users include long waiting time, uncertain bus travel time, uncertain trip frequency, trip cost, and overcrowding of

buses. This is similarly the case in the Metropolitan city of London, where the main complaints about their bus services is the less than desirable punctuality in services (Wall and McDonald, 2007).

Lack of passenger comfort is another issue when using bus services according to the surveyed respondents. Users complained that bus drivers take up too many passengers on-board. As a result, the bus becomes overcrowded which leads to lack of comforts for passengers. Similar findings were also recorded for the bus services in Istanbul, where Yazici et al. (2013) found that users for the Metrobus services was dissatisfied with the travel cost, as well as the overcrowded buses. The overcrowded bus problem resulted in drivers having to deal with nagging passengers as well passengers who skipped paying bus fares as the drivers are unable to cope with their high boarding and alighting rates. Drivers also believed that this problem is due to the conventional payment system that uses paper tickets.

In another study on solutions to transportation woes, Wang and Law (2007) found there is positive impact of ICT application on time use and travel behaviour of public transport users, which could be similarly used to solve similar issues experienced in public transportation services in the current study. Therefore, users and drivers' intention to use ICT application were also investigated in this study based on three main components of TAM model: perceived usefulness, ease of use, and awareness. According to the result, ICT application that supports green technology for bus services must provide information regarding the cost and payments, provides proof of payment and reimbursement, display travel map, information of current traffic condition, as well as the information of driver profiles. The drivers also agreed with users in term of proof of payment and reimbursement is very important for ICT application. However, respondents perceived that the consumer's acknowledgement was less important.

For the second component, in term of ease of use of ICT application, users and drivers highlights the need of the ICT application to display information in both languages; Bahasa Melayu and English language. Users also agreed that the ICT application is accessible from any types of smart phone. More interesting, bus drivers disagreed on the item "Payment can be made online (e.g.maybank2u)". This finding shows that drivers are sceptical on the online payment system. Users do not feel safe since security is essential condition for the payment system using ICT application (Hung et al., 2006; Linck et al., 2006).

Based on users' interview, most comments highlighted the application of ICT as a viable solution. Examples of such comments were "uses touch N go and online payment method", "introduces mobile and internet application", and "uses of better website application". The users and drivers also suggested

the uses of mobile application. Bus drivers highlighted the uses of online ticketing, the uses of touch N go, and the online payment method. Additionally, previous study suggests the availability of technical support is another attributes that enhances users' perceived ease of use of ICT application (Thompson et al., 1991).

For the third component of TAM model, regarding awareness of green technology (all aspects including the uses of ICT application), the majority of users acknowledged that green technology has been practiced in Melaka. Besides suggesting the ways of how green technology practices can be realised such as in, "using website application", "using mobile internet application", and "implementing touch N go and online payment system", some respondents among bus drivers also suggest "using of NGV for green technology" for sustainable environment. Although respondents seems to be aware but they are not well informed on green technology, since majority of them do not understand the purpose and meaning of green technology being practiced in Malacca. Understanding and knowledge is important in helping to solve environmental problems and practices relating environmental protection, conservation, as well as creating positive values (Ganai and Zargar, 2013). It is probably for that reason, that both users and drivers do not integrate green technology in their daily lifes.

5 CONCLUSION

The study seeks to develop a greater understanding of public transportation issues and challenges in its provision as well as to identify potential green technology solutions to deal with the issues. The TAM model was used as the framework in evaluating users' and drivers' intention to use a proposed technology, by assessing their perceptions towards the attributes of a proposed technology namely, its perceived usefulness and ease of use. The data indicate that public transport users have needs that can be alleviated with the use of technology and the technology suggested is an ICT application. These findings support the need to develop an online system that can help to alleviate some of the problems facing public transportation, especially drivers and users. The application of an online system will improve efficiency of public transportation services and management via reduction in waiting and travelling time, as well as management cost. Ease of use of the ICT application however must fulfil essential requirements including high security level for online payment and availability of technical support. Drivers and users' awareness towards the application and usefulness of green technology is however not very high which means that further actions are necessary to increase awareness and appreciation of green

technology to promote success in future implementations of green technology. In conclusion, the findings of this study as a whole are useful in providing support - based on empirical data - for the development of an ICT application as a green technology solution for meeting the needs of stakeholder of public bus transportation industry.

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