# A Conceptual Framework of a Travel Demand Modeling for a Public Transport System

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*Abstract*—**This paper presents a conceptual framework relating to a demand modeling that links socio-economic, customer satisfaction and feeder bus system acceptance factors to the demand of the electric train services provided by KTM Malaysia. The model in this framework will serve as a predictive model for the demand pattern of ETS coupled with the demand for the services of its feeder bus system. The proposed framework will be developed with the theoretical underpinning as follows: activities based travel demand model, classic transport demand supply function, a unified theory of consumption and travel, utility theory travel demand model, and the theory of planned behavior. From these theories, four constructs and their measurement variables are highlighted in the study.**

*Keywords*—*public transport; demand model; socio-economic; factors; feeder bus system; customer satisfaction*

## I. INTRODUCTION

An increase in population generates increasing travel demand. An increase road length and new roads generate faster and longer trips by car ownership. An explosive growth in vehicle ownership has left Malaysia facing traffic congestion, pollution, accidents, depletion of resources, and inaccessibility of amenities and services. In this situation, government policy encourages people to use public transport, such as commuter trains, buses, minibuses, electric train service (ETS), light rail transit (LRT) and taxi to solve these problems. For instance, the electric train service (ETS), which was launched in mid-2010 between the major cities of Ipoh, Kuala Lumpur and Seremban, is aimed at reducing cost and time of intercity travel without the need to drive. It offers a faster, safer, more reliable and greener way to travel. Furthermore, with ETS, congestion on roads and fuel consumption can be reduced, effectively minimizing our impact on the environment. Eventually, this service will be extended to other cities, such as Butterworth and Johor Bahru once the double electrified tracks from the northern and southern regions are completed. The social, economic, and environmental benefits of using ETS make it an attractive transportation option to advocate for. With regard to this, public transport should become part of a solution for sustainable transport in the future.

The electric train service (ETS) can potentially bring huge socio-economic benefits not only to the people but also to the nation in line with the government's economic transformation program. However, like any other public transportation, the vision is to attract as many users as possible. To be successful in its vision, the whole system must be effective and efficient, and needs to be updated as well. Nowadays, there is a growing use of ETS but people using this are less than as compared to private vehicle use. This is even though people understand that private vehicles can cause traffic congestion, longer travel time, pollution and high consumption of non-renewable energy resources. At present, the weakest link in the whole system in the state of Perak is the door-to-door service which provides accessibility of the passengers to the ETS. This can be overcome by introducing an effective feeder bus system (FBS). An effective FBS enhances connectivity to city centers, local public transportation system hubs and densely populated suburbs. Many studies have been carried out on the demand for public transport; however, discussion on the impact of factors affecting the demand modeling is by no means exhaustive. Hence, there is a need to study the relevant factors affecting the demand pattern of ETS coupled with the demand for the services of its feeder bus system in the state of Perak, Malaysia.

## II. LITERATURE REVIEW

### A. Socio-Economic Factors

Many studies have been carried out on the demand for public transport. Most of the socio-economic factors were found to be significant. References [1] and [2] have found a higher probability to shift to public transport among females. According to [3] and [8], males were less likely to shift to public transport and had a stronger preference to drive. Indeed, women discovered in Malaysia were more likely to use public transport [4]. The age has also shown a significant contribution to public transport as well. A positive relationship between the age and the likelihood to use public transport was established referring to [5]. If the minimum legal driving age is raised and the quality of public transport service is improved, the younger people are willing to shift to public transport [6]. Other factors, such as education, income, household size, vehicle ownership, license ownership, and vehicle availability have also been studied in previous researches. For instance, when choosing mode of transport, passengers with a higher income tended to be less concerned about fare difference [7]. It was stated that, in Penang (Malaysia) with a personal income of above RM 3000, there was a lower tendency to use public transport [8].

According to [5], the use of cars was positively related to income, household size, and car license ownership. Households with a large number of adults appeared to have a stronger demand for taxi and bus services due to the competition for the use of the car(s) owned by the household [8].

## B. Customer Satisfaction

Satisfaction is a cumulative construct that is affected by market expectations and performance perceptions in any given period, and is also affected by past satisfaction from period to period [9]. References [10], [11], and [12] stated that customer satisfaction lies in the disconfirmation of the customer expectation paradigm; whereas, a positive disconfirmation leads to customer satisfaction and negative satisfaction leads to customer dissatisfaction. One of its benefits is that satisfaction is generally seen as the main driver of customers' favorable behavioral intentions [13]. Customers' favorable behavioral responses, such as repurchase and positive word of mouth, would be obtained by the organization if the customers were satisfied [14]. Empirically, previous studies have confirmed a direct positive relationship between satisfaction and behavioral intention in various industries [15] including public land transport services [13]. Customer Satisfaction and Service Quality in recent times, for all organizations, the importance of customer satisfaction has become increasingly understood. For many organizations in the public sector, customer satisfaction will itself be the measure of success. According to [10], satisfaction was defined as the customer's fulfillment. It was a judgment about the product or service feature. It was also related to the pleasurable level of consumption-related fulfillment, including levels of under- or over-fulfillment. The need for fulfillment is a comparative processes giving rise to the satisfaction responses. Any gaps lead to disconfirmation, i.e., positive disconfirmations increase or maintain satisfaction and negative disconfirmation creates dissatisfaction. Service quality is defined as a comparison between customer expectation and perception of service [16], [17]. Service quality, in general, consists of five distinct dimensions: tangibles (Physical facilities, equipment, and appearance of personnel), reliability (ability to perform the promised service dependably and accurately), responsiveness (willingness to help customers and provide prompt service), assurance (knowledge and courtesy of employees and their ability to inspire trust and confidence), and empathy (caring, individualized attention the firm provides to its customer). References [18] and [10] stated that, in order to keep and attract more passengers, public transport must have high service quality to satisfy and fulfill a wide range of different customer's needs. It is important to understand what drives customer satisfaction and dissatisfaction towards public transport, so that we can help to design an attractive and marketable public transport. Reference [19] summarized advantages in using public transport according to Portugal public transport users. The result highlights the importance of a cost friendly and less stressful public transport service. It is perceived as less stressful since there is no need to drive, it is possible to relax and one may be able to rest or read. A mail survey was conducted to investigate factors affecting customer satisfaction in a public transport service in Sweden [20]. The results showed that the overall cumulative satisfaction was related to attribute specific cumulative satisfaction and remembered frequencies of negative critical incidents, for instance, the driver behaves unexpectedly bad or the bus is leaving before the scheduled departure time. References [21] and [22] found the safety issue as a constraint for people to choose public transport as the travel mode of choice. Pick pocketing, overcharging facilitates, overcrowding and lack of supervision are the most related safety issueg [21], [23]. Two important factors, availability and accessibility to public transport were highlighted [24]. The findings from [25] provided strong evidence for the conclusion that individuals prefer options yielding shorter travel time as well as an alternative with high frequency of public transport. According to [34], frequency, price, punctuality and travel time factors play a strong influence on the overall customer satisfaction to improve, and develop attractive and marketable public transport. In addition, [34] also studied passenger preference and satisfaction of the public transport in Malaysia using a statistical model that included variables, such as facilities, comfortness and quality of service. The result was found that the influences of the satisfaction parameters are more than those of the preference parameters.

## C. Feeder Bus Acceptance

The feeder bus system is the service that picks up and delivers passengers to a rail rapid transit station or express bus stop. A deep understanding of a passenger's perceptions, attitudes and behavior are needed because travel behavior is complex. Reference [26] stated that the choice of travel mode is largely a reasoned decision. This decision can be affected by interventions that produce a change in attitudes, subjective norms, and perceptions of behavioral control. Also, it is evident that the past travel choice contributes to the prediction of the later behavior only if the circumstances remain relatively stable. In the study, a pre-post design was used to examine the changes in university students' bus ridership after the implementation of a universal bus pass (U-pass) program. The bus ridership significantly increased after the U-pass was implemented and associated changes in attitudes and beliefs about transportation modes were found. A market study of short-haul feeders is the first step toward deployment of the smart feeder bus service. A good understanding of user needs and desires and how new technologies can enhance a smart feeder bus service are important issues [33]. The gender, auto ownership, ethnicity, and employment status are strongly associated with the interest in using a smart feeder bus service. Furthermore, the most important attributes in the design of a feeder bus service are the cost, travel time, and reliability of the service.

## III. CONCEPTUAL FRAMEWORK

### A. Theorectical Framework

In this study, a proposed conceptual framework will carry out the effective linking of socio-economic factors, satisfaction and factors that influence the travel demand model. The model has been based on the theories of:

*1) Activity based travel demand modeling [27]:* Activity based travel demand models predict travel behavior as a

derivative of activities. Therefore, by predicting which activities are performed at a particular destination and time, trip, and their timing and locations are implicitly forecasted in activity based models.

*2) Classic transport demand supply function [28]:* Many transport systems behave in accordance with supply and demand, which are influenced by cost variations. In line with micro-economic theory, the Law of Demand states that the demand for transport services decreases when the price of this service increases. This is reflected in the transport demand curve which plots the aggregate quantity of a transport service that consumers are willing to buy at different prices, holding constant other demand drivers, such as prices of other transport services and goods, the budget or income and quality aspects, such as reliability.

*3) A unified theory of consumption and travel [29]:* The theory focuses on the important roles of income, the value of time which is related to income, and the substitutability among alternative trip destinations.

*4) Utility theory travel demand model:* It was designed to forecast [30]:

- The amount of total travel generated by types of households,

- The division of travel among available modes, and

- The relationship between the time and money allocated to travel expenditures.

*5) The theory of planned behavior:* The theory of planned behavior (TPB) was developed [31]. The theory proposes a model which can measure how human actions are guided. It predicts the occurrence of a particular behavior, provided that behavior is intentional. An expanded version of the theory of planned behavior (TBB) was proposed to predict and explain public transportation use [32].
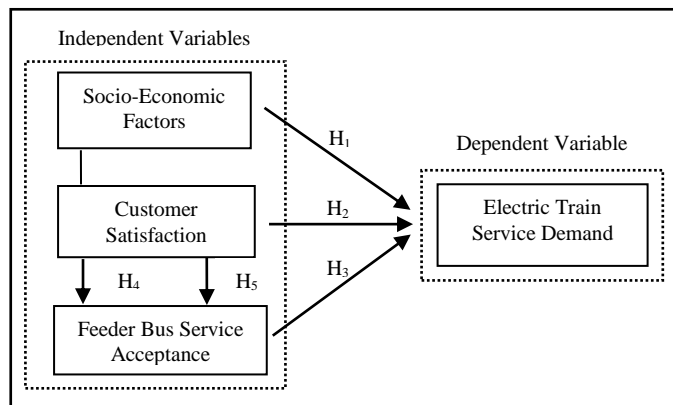


Fig. 1.  Proposed conceptual framework for the ETS demand model.

*B. Hypothesis*

Based on the proposed framework, it can be hypothesized as follows:

$H_1$: The socio-economic factors have a significant correlation with the ETS demand.

$H_2$: There is a positive correlation between the customer satisfaction factors with the electric train service (ETS) demand.

$H_3$: There will be changes in the ETS demand after implementation of a feeder bus system (FBS).

$H_4$: The socio-economic factors have a significant correlation with the feeder bus service acceptance.

$H_5$: There is a positive correlation between the customer satisfaction factors with the feeder bus acceptance.

*C. Construct Measurement*

In the proposed conceptual framework for this research, there were four constructs; where, three were independent variables and one was a dependent variable. The dependent variable was the ETS demand. The three independent variables were the socio-economic factors, customer satisfaction and feeder bus system.

In relation to the theorized correlation for an effective ETS demand model as depicted in Fig.1, a data collection instrument through a survey questionnaire was developed to collect data for the factor analysis. The questionnaire parameters captured all of the important elements measuring up the four hypothesized constructs. To facilitate the use of statistical procedures, all of the constructs were quantitatively measured in the questionnaire in the following manner:

*1) ETS demand:* The ETS demand was the dependent variable proxied by a measurement metric made up of survey statements (elements) presented to the respondents for their assessment. These survey statements came in the form of many multiple choices covering five statements using items A1 to A5 as shown in Table 1. The statements gauged the respondents' agreement choice in regards to the description of various elements found in, or impacts resulted from the respondents.

TABLE I.  CONSTRUCT AND VARIABLES FOR DEPTH OF ETS DEMAND

| No. | Variables |
|---|---|
| A1 | Trip frequency |
| A2 | Trip purpose |
| A3 | Distance of travel |
| A4 | Choice of mode |
| A5 | Most important reason for using ETS |

*2) Socio-economic factors:* The second construct in the theorized effective ETS demand relationship model was the socio-economic factors measures. This socio-economic factor was an objective measurement consisting of items B1 to B13 as shown in Table 2. There were eleven statements presented to the respondents for their agreement assessment in a multiple-choice format.

TABLE II. CONSTRUCT AND VARIABLES FOR THE DEPTH OF THE SOCIO-ECONOMIC FACTORS

| No. | Variables |
|---|---|
| B1 | Gender |
| B2 | Marital status |
| B3 | Age |
| B4 | Household size |
| B5 | Occupation |
| B6 | Education |
| B7 | Income |
| B8 | Household income |
| B9 | Income spent for transport |
| B10 | Household income spent for transport |
| B11 | Vehicle ownership |
| B12 | Availability of vehicle |
| B13 | Preference |

*3) Customer satisfaction:* The customer satisfaction was a perceived measurement presented as a factor to potentially affect the ETS demand. This construct was proxied by 9 sub-constructs with a total of 37 items measured in the 5-point Likert's scale from 1 (strongly dissatisfied) to 5 (strongly satisfied).

TABLE III. CONSTRUCT AND VARIABLES FOR THE DEPTH OF THE CUSTOMER SATISFACTION LEVEL

| Sub-construct C | No. | Variables |
|---|---|---|
| C1. Accessibility Quality | a1 | Ability to catch the train |
| | a2 | Ease of boarding the train |
| | a3 | There is direct bus from near your home to the train station |
| | a4 | The amount of car parking provided |
| | a5 | There are a lot of connections from where you get off |
| C2. Timeliness Quality | b1 | Travel time considering the distance of travel |
| | b2 | Punctuality of the train (keeping to timetable) |
| | b3 | Frequency of the train |
| C3. Cleanliness Quality | c1 | The general cleanliness of the train |
| | c2 | The general cleanliness at the station |
| | c3 | The level of graffiti and the litter in the train |
| | c4 | The level of graffiti and the litter at the station |
| C4. Information Quality | d1 | The availability of up-to-date timetable at the station |
| | d2 | The number and clarity of announcements on the train |
| | d3 | The number and clarity of announcements at the station |
| | d4 | Helpfulness of the train staff about the information |
| C5. Comfort Quality | e1 | Seat availability and comfort on the train |
| | e2 | Seat availability and comfort at the station |
| | e3 | Temperature level on the train |
| | e4 | The level of light provided |
| | e5 | The train journey comfort (smoothness of ride) |

| | e6 | Facility of disable persons |
|---|---|---|
| C6. Ticketing Quality | f1 | The amount of ticket information provided |
| | f2 | Ease of understanding the ticket information provided |
| | f3 | The ease of being able to purchase a ticket |
| | f4 | Liquidity of the ticket |
| | f5 | Price of the ticket |
| C7. Safety Quality | g1 | Safety on board during the day |
| | g2 | Safety on board during the night |
| | g3 | Safety from crime while riding during the day |
| | g4 | Safety from crime while riding during the night |
| | g5 | Safety related to behavior of other persons during the day |
| | g6 | Safety related to behavior of other persons during the night |
| C8. Reliability Quality | h1 | Shows sincerity in solving customers' problem |
| | h2 | Performs the service right at the time |
| | h3 | Provides service at the time promised |
| | h4 | Maintains error-free records |

*4) Feeder bus system acceptance:* The feeder bus system was an independent factor proxied by 6 sub-constructs. This construct was made up to predict changes in electric train service ridership after the implementation of the feeder bus system, and associated changes in attitudes and beliefs about the transportation modes as shown in Table 4.

TABLE IV. CONSTRUCT AND VARIABLES FOR THE DEPTH OF THE FEEDER BUS SYSTEM

| No. | Variables |
|---|---|
| D1 | Trip characteristics |
| D2 | Mode of access transportation to ETS |
| D3 | Willingness to use a feeder bus service |
| D4 | Willingness to pay for the service |
| D5 | Attitude toward the feeder bus service usage |
| D6 | Behavioral intention in using the feeder bus service |

## IV. METHODOLOGY

This section presents the research approach used in this study, research design, sample selection methods, data collection methods, and method of analysis. The procedure can be shown as follows:

### A. Research Design

The independent variables that will be used in this study are the socio-economic factors (age, gender, marital status, number of members in the household, occupation, education, income, proportion of monthly income spent for transport, vehicle ownership, availability of vehicle and preference) customer satisfaction (accessibility, timeliness, cleanliness, information, comfort, ticketing, safety, reliability, and convenience) and the implementation of the feeder bus system (trip characteristics, mode of access transportation to ETS, willingness to use a

feeder bus service, willingness to pay for the service, attitude toward the feeder bus service usage, behavioral intention in using the feeder bus service). The dependent variable is the level of demand for the electric train service in the state of Perak.

## B. Sampling Design

The variable data collection is based on the survey questionnaire setting for this study will provide by the passengers of electric train service (ETS). The respondents will be asked at the current train stations (Ipoh, Batu Gaja, Kampar and Tanjung Malim) or at their convenient time. The target respondent is in the range of ages between 18 and 60 who had experience using this electric train service. The age range of 18 to 60 years old is chosen because people in this age have a routine commuting travel behavior and probably had taken the electric train service as their mode of choice. From the age of 18, the youth usually have to go to a school that is not in their own neighborhood. After the age of 60, people usually may not have a routine commuting behavior because they already have a pension.

## C. Data Collection Instrument

Self-rating and handing out questionnaires will be used as a data collection method in this study. The structured questionnaire contained four sections. The first section will be used to gather the electric train service factors (dependent variable). There are 5 items in this part. The second, third and the last sections are the independent variables. The second section of the questionnaire will be used to gauge the various aspect of socioeconomic factors which contain of 13 items. The third section will be used to measure the customer satisfaction factors. There are 9 sub-sections with a total of 36 items. The last section will be used to measure the various aspect of feeder bus service which contain of 6 sub-sections. Reasons of using four sections questionnaire in order to collect data are to understand the aim of each section questionnaire and to offers confidentiality.

## D. Analytical Modeling

The aim of this study is to measure socioeconomic, satisfaction factors and the implementation of feeder bus system on the demand of electric train service. SPSS software will be used for data input and analysis. Data analysis will be conducted in four steps. Firstly, reliability analysis will be used to test the reliability for the internal consistency of the construct scales in figure 1. Secondly, factor analysis will be performed with the aim to identify group or cluster of variables. Thirdly, correlation analysis will be undertaken to measure linear correlation between variables to test the five hypotheses. Finally regression will be conducted to evaluate the contribution of each factor on the electric train service demand modeling.

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