DEVELOPMENT OF PASSENGER FLOW TIME (PFT) MODEL FOR LIGHT RAIL TRANSIT (LRT) USERS AT KL SENTRAL MALAYSIA

HOR PEAY SAN

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This thesis is dedicated to Abba Father,

Dad and Mum, my sisters,

and my spiritual family Hope Batu Pahat.

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ABSTRACT

Dwell time is a key parameter of system performance, service reliability and quality in any mode of public transportation and represents a significant portion of the total trip time along a serviced transit line. One major component of dwell times is the alighting and boarding time of passengers, also known as passenger flow time (PFT). This mainly depends on the number of passengers alighting and boarding and the speed they do it. In Malaysia, there has yet to be an extensive study conducted on the alighting and boarding process in urban rail services. Thus, the aim of this research is to develop a predictive model to estimate the PFT through a train door of light rail transit (LRT) at KL Sentral. With this model, the main factors affetcting the PFT at a door and characteristics of the process of alighting and boarding were able to be identified. Data collection for this research was conducted both empirically and experimentally. Empirical data was collected at KL Sentral LRT station during peak hours (07:00 to 09:00 hrs) and non-peak hours (17:00 to 19:00 hrs) for a period of one week. Observations show that passengers at KL Sentral behave differently in the way they alight and board the train during peak and non-peak hours. Results reveal that the main factors affecting the PFT at a train door are the volume of alighters and boarders and the level of crowdedness in the train. It was also found that it is more relevant to apply separate models for peak hour and non-peak hours of the LRT passengers due to the different ways of alighting and boarding the train. With the models developed using the experimental approach and calibrated with the empirical data, the models proved to be significant in estimating the PFT of LRT users at KL Sentral. This will enable the rail service operator to estimate the optimum dwell time for passengers to alight and board the train during peak and non-peak hours. Besides, they can estimate the frequency of the train during peak and non-peak hours to ensure the maximum efficiency and effectiveness of the LRT system.

ABSTRAK

Masa berhenti merupakan suatu parameter yang penting untuk tahap kecekapan, kebolehpercayaan dan kualiti dalam apa jua mod pengangkutan awam dan merangkumi sebahagian yang penting daripada jumlah masa trip di sepanjang transit. Salah satu komponen penting masa berhenti ialah masa yang diperlukan untuk penumpang keluar dan masuk tren, yang juga dikenali sebagai masa aliran penumpang (PFT). Ia bergantung pada jumlah penumpang yang keluar dan masuk dan kelajuan proses itu. Di Malaysia, tidak ada lagi kajian menyeluruh yang dilakukan ke atas proses penumpang keluar dan masuk tren dalam servis rel bandaran. Oleh itu, tujuan kajian ini adalah untuk menghasilkan satu model yang dapat mengaggarkan PFT pada satu pintu transit aliran ringan (LRT) di KL Sentral. Dengan terhasilnya model ini, faktor utama yang mempengraruhi PFT di suatu pintu dan ciri-ciri proses keluar dan masuk tren dapat dikenalpasti. Pengumpulan data untuk kajian ini telah dilakukan dengan kaedah empirik dan eksperimen. Data empirik dikumpul di stesen LRT KL Sentral pada waktu puncak (7:00 hingga 9:00 AM) dan bukan puncak (5:00 hingga 7:00 PM) untuk satu minggu. Pemerhatian menunjukkan bahawa penumpang di KL Sentral berkelakuan berbeza dalam cara mereka keluar dan masuk tren pada waktu puncak dan bukan puncak. Hasil analsis mendedahkan bahawa faktor utama yang mempengaruhi PFT pada suatu pintu tren ialah jumlah penumpang dan tahap kesesakan di dalam tren. Selain itu, model yang berbeza untuk waktu puncak dan bukan puncak juga didapati lebih sesuai untuk digunakan untuk penumpang LRT di KL Sentral kerana cara keluar dan masuk tren yang berbeza pada waktu-waktu tersebut. Dengan adanya model yang dihasilkan dengan menggunakan kaedah eksperimen dan dikalibrasikan dengan data empirik ini, ia terbukti penting dalam menganggarkan PFT penumpang LRT di KL Sentral. Ini akan membolehkan pengendali servis rel untuk menganggar masa berhenti yang

optimum untuk penumpang keluar dan masuk tren pada waktu puncak dan bukan puncak. Selain itu, mereka juga boleh menganggar kekerapan tren pada waktu puncak dan bukan puncak untuk memastikan kecekapan dan keberkesanan maksimum sistem LRT tersebut.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

ABM	-	Agent-based modelling
hrs	-	Hours
KL	-	Kuala Lumpur
KLIA	-	Kuala Lumpur International Airport
KTMB	-	Keretapi Tanah Melayu Berhad
LOC	-	Level of crowdedness
LOS	-	Level of service
LRT	-	Light Rail Transit
MAPE	-	Mean absolute percentage error
MTR	-	Mass Transit Railway
p	-	Probability value
PATH	-	Port Authority Trans-Hudson
PFT	-	Passenger flow time
r	-	Correlation coefficient
R^2	-	Coefficient of determination
s	-	Second
SPAD	-	Suruhanjaya Pengangkutan Awam Darat / Land Public Transport Commission Malaysia
TCRP	-	Transit Cooperative Research Program
TRB	-	Transportation Research Board
VIF	-	Variance influential factor

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of research

In moving towards being a developed nation by 2020, Malaysia's transport system is one very important aspect that must be looked into. Rail transport is gaining momentum in Malaysia, with the latest ongoing project, the Klang Valley Mass Rapid Transit (MRT) Project in the Greater Kuala Lumpur, the East Coast Rail Link (ECRL) and the proposed Kuala Lumpur-Singapore high speed rail link project. At the same time, there are current rail-based transportation systems such as the Keretapi Tanah Melayu Berhad (KTMB) intercity train services, Light Rail Transit (LRT), KTM Komuter, KL Monorail and airport services such as KLIA Ekspres and KLIA Transit. In its report entitled *Touching Lives Connecting Communities* (Land Public Transport Commission, 2016), the Land Public Transport Commission (SPAD) reported that the average daily ridership in 2015 for the urban rail network is 631,680 passengers per day, in which the Kelana Jaya LRT service had the highest passenger load. The busiest stations, according to the report included the main interchanges such as Masjid Jamek and KL Sentral. It is expected that the daily ridership will continue to increase based on the current trend. Yet, the morning peak (7 to 9 am) modal share for public transport was very low at 10-12% in 2008, as compared to Hong Kong (90%) and Singapore (63%) (Land Public Transport Commission, 2011). Train punctuality is a very important attribute of the public transport system. The perceived utility of the system will definitely decrease if trains are late or cancelled very often. (Alwadood, Shuib, & Abd. Hamid, 2012)

1.2 Problem statement

Past researches conducted in regards to punctuality of rail services in Malaysia show that, generally the public did not have a good perception towards the rail services in Malaysia. For example, Abdul Sukor, *et al.* (2013) found out that 82% of the respondents perceived that the KTM Intercity train service would not arrive on time, with 47% of the respondents ranked the service poor in regards to punctuality of the service. It was also reported that a 40-minute delay or more was quite common in the urban commuter rail system, KTM Komuter (Bernama, 2011). A research conducted by Waris *et al.* (2010) found out that 67% of the respondents stated that the KTM Komuter trains were always delayed.

According to Puong (2000), dwell time is a key parameter of system performance, service reliability and quality in any mode of public transportation. Dwell time represents a significant portion of the total trip time along a serviced transit line, thus affecting travel time and system capacity. In rail transit systems with short headways and running times between stations that are generally non-varying across trains, dwell time is the main factor causing headway variability. Higher headway variability lowers service reliability in terms of punctuality, and causes service quality to decrease through longer waiting times and higher on-board crowding levels.

One major component of dwell time is the alighting and boarding time of passengers, also known as passenger flow time. According to Seriani & Fernandez (2015), this mainly depends on the number of passengers alighting and boarding and the speed they do it. The dwell time of trains at stations become more dependent on the passenger flow time as the passenger demand at a station increases. This is especially for rail systems with high frequencies such as the LRT and MRT. Thus, good management of passenger movement during the alighting and boarding process at urban rail services plays a significant role in the overall system performance improvement (Baee *et al.*, 2012). Besides, as seen in Figure 1.1, Chu *et al.* (2015) highlighted the importance of passenger flow time at each door upon the dwell time of a train.

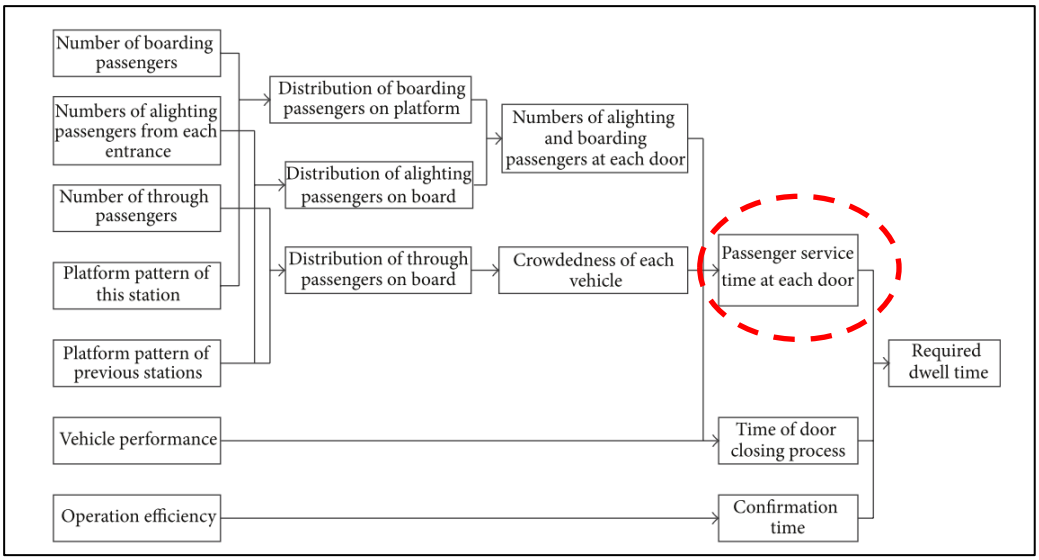

Figure 1.1 Factors of urban dwell time (Chu *et al*., 2015)

In Malaysia, there has yet to be an extensive study conducted on the alighting and boarding process in urban rail services. Though there are currently various models from different parts of the world to estimate the alighting and boarding time of passengers, these models vary by specificationis of the train and platform and human behaviours. Therefore, the alighting and boarding time model based on a certain country or a line cannot be applied blindly to other cases (Harris & Anderson, 2007). Thus, it is important to conduct a research to study the process of alighting and boarding of LRT passengers at platforms specifically suitable for the Malaysian context.

1.3 Aim and objectives

The aim of this research is to develop a predictive model that is able to estimate the passenger flow time through a train door of LRT passengers at KL Sentral.

The objectives of this research are:

(a) To identify the main factors affecting the passenger flow time at a train door.

(b) To determine characteristics of the process of alighting and boarding a train door.

(c) To evaluate the different types of alighting and boarding methods at a train door using experimental approach.

1.4 Scope of research

This research was conducted for urban rail services in Malaysia during peak and off-peak hours. KL Sentral LRT station on the Kelana Jaya Line was selected as the location to collect the data needed for this research.

Parameters considered in this research are as follow:

(a) volume of passengers
(b) time of operation
(c) passenger flow composition
(d) passenger flow time
(e) crowdedness in the train
(f) type of alighting and boarding

This research is focussed on studying the process of alighting and boarding at a train door. As such, the parameters above are measured in terms of "per door".

1.5 Thesis outline

This thesis consists of six chapters in total. Chapter 1 gives a brief overall introduction of the research work conducted, aim, objectives, scope of study and the contribution to knowledge.

Chapter 2 reviews critically the current knowledge relating to the research, including literature on theoretical and methodological contributions and review of previous dwell time models.

Chapter 3 describes the process and steps taken to conduct this research, which can be categorised into four phases, namely preliminary study, empirical study, experimental study and development of predictive models.

Chapter 4 presents the results from the research conducted. Results were analysed, compared and critically reviewed to understand how various factors affect the passenger flow time.

Chapter 5 explains the development process of the predictive model that can be used to estimate the passenger flow time. The experimental and empirical models were calibrated to produce a final model.

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