A STUDY ON RIDERSHIP CAPACITY ANALYSIS AT RAPID KELANA JAYA LINE STATION

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Dedicated to all my beloved peoples

MOHD ARIF MAHADI & ZAITON ISHAK,

MOḤD FAIZ & NASIHAH, NURUL FARHANA & AHMAD HUMAIZI,
MUHAMMAD FAIZUL & FAIZURA NAQUIAH,

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Who always be there for me

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ABSTRACT

Level of Service (LOS) is commonly used to access the quality of operations of transportation facilities at the roadside. However, LOS, measures for pedestrian facilities such as waiting areas are not well developed until now. The main objective of this study is to determine the level of service of platform at KELANA JAYA LINE KL SENTRAL station, in order to identify the current operational conditions. Objectives are achieved by referring to LOS standards from Highway Capacity Manual (2000) and Transit Capacity and Quality of Service Manual (TCQSM). Additionally, analysis has been carried out for peak hours and focus on KL Sentral Station platform. Results showed that, LOS at platform was LOS E and there are a few LOS D and LOS A during the peak hours. The probability of worse LOS levels in the future are high. Based on analysis data, access way front and the end of platform edge were identified as areas that are highly crowded. Results from this study could be used as a guide by authorities and management team of the station to detect and monitor the LOS of the platform. Hence, could provide better service that matches the right level of service and provides higher passenger comfort, while using the service. The capacity of a transit mode refers to how many passengers per hour a mode can be expected to carry. Since when we discuss capacity we are usually discussing it in terms of a rapid transit project, the capacity should be defined as the maximum number of passengers per hour a given mode could carry at its maximum average operating speed. Overall, the capacity of a given transit mode expressed in passengers per hour can be represented as the result of multiplying the number of vehicle trains that could pass by a particular stop in one hour which is frequency by the number of vehicles per train and the number of passengers that could be carried by each vehicle.

ABSTRAK

Tahap Perkhidmatan (LOS) biasanya digunakan untuk mengakses kualiti operasi kemudahan pengangkutan di tepi jalan. Walau bagaimanapun, LOS, langkah-langkah untuk kemudahan pejalan kaki seperti kawasan menunggu tidak maju sehingga kini. Objektif utama kajian ini adalah untuk menentukan tahap perkhidmatan platform di KELANA JAYA LINE stesen KL SENTRAL, untuk mengenal pasti keadaan operasi semasa. Objektif dapat dicapai dengan merujuk kepada piawaian LOS dari Highway Capacity Manual (2000) dan Transit Kapasiti dan Kualiti Perkhidmatan Manual (TCQSM). Selain itu, analisis telah dijalankan untuk waktu puncak dan memberi tumpuan kepada platform Stesen KL Sentral. Hasil kajian menunjukkan bahawa, LOS di platform adalah LOS E dan terdapat beberapa LOS D dan LOS A semasa waktu puncak. Kebarangkalian tahap LOS lebih teruk pada masa akan datang adalah tinggi. Berdasarkan analisis data, akses jalan depan dan akhir tepi platform telah dikenal pasti sebagai kawasan-kawasan yang sesak. Hasil daripada kajian ini boleh digunakan sebagai panduan oleh pihak berkuasa dan pihak pengurusan stesen untuk mengesan dan memantau LOS platform. Oleh itu, boleh memberikan perkhidmatan yang lebih baik yang sepadan dengan tahap hak perkhidmatan dan memberi keselesaan penumpang yang lebih tinggi, semasa menggunakan perkhidmatan ini. Kapasiti mod transit merujuk kepada berapa banyak penumpang satu jam yang boleh diharapkan untuk dibawa. Oleh kerana ketika kita membincangkan kemampuan kita biasanya membincangkannya dari segi projek transit yang cepat, kapasiti harus ditakrifkan sebagai jumlah maksimum penumpang per jam mod yang diberikan dapat membawa pada kecepatan operasi rata-rata maksimum. Secara keseluruhannya, keupayaan mod transit yang dinyatakan dalam penumpang sejam boleh diwakili sebagai hasil daripada mendarabkan bilangan kereta kebal yang boleh lulus dengan perhentian tertentu dalam satu jam yang kekerapan oleh bilangan kenderaan kereta api dan nombor Penumpang yang boleh dibawa oleh setiap kenderaan.

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CHAPTER 1

INTRODUCTION

1.1 Background of the study

Nowadays traffic congestion reduction is widely considered as one of the most common reasons for building new transit systems. Today, the demand for rail networks across the globe is increasing, hence the rail operation is getting busier. Additionally, they became the most preferable public transportation choice by the users. To avoid congestion in traffic, railway transportation mode is the best option offered to the public, since it is ease of use. As a developing country, Malaysia depends on an urban transportation system that is effective and efficient.

As passenger distribution nodes, rail transit stations are one of the public buildings that have the highest pedestrian density. In the year 2000, world urban population reached 2.9 billion and it is expected to increase to 5.0 billion by 2030 (Tom *et al*, 2006). Meanwhile, the effects of high passenger density at bus stops, rail stations, buses and trains are diverse.

On the other hand, when an area is filled with people, we will be able to see different patterns of walking behaviors, various kinds of interactions of each person and various movements that lead to different levels of comfortability and disrupt of service. For example, at a train station, crowding conditions at station platform critically affect 2 the behavior of passengers and the dwelling time of trains, which as a result has an impact to the line capacity (William *et al.,* 1999).

Hence, governments, operators and other agencies involved in providing service to customer should be able identify their customer needs and how they feel about the goods or services provided. Level of Service (LOS) of pedestrian can be applied to evaluate these provided services.

Level of Service (LOS) is a method by which a transportation facility's performance is evaluated. In general term, it is a quantitive measure describing operational conditions of a facility stream and user perception of those conditions within an area of evaluation (Klodzinski, 2001). Thus, LOS is generally used to determine the effectiveness of a facilities performance, including traffic jam in highway or signalized intersection.

By selecting a platform in a LRT station for the case study, a research was conducted to evaluate the level of service of passenger flow and the results of research has been analysed. The method used to determine the (LOS) for pedestrian is adapted from the Highway Capacity Manual (HCM) and Transit Capacity and Quality of Service Manual (TCQSM). Computer simulation of pedestrian movement is a useful method to help designers to understand the relation between space and human behavior.

Pedestrian simulations are used to analyze pedestrian flows, for example at airports and railway stations (Dallmeyer et al., 2012). A software for this kind of studies is often used with the focus on pedestrian density and evacuation issues.

1.2 Problem statement

Based on "My Rapid Train Frequency" peak hours report, train frequency cycle average is 3 minutes. However, waiting areas cannot provide adequate space for passengers. Furthermore, inadequate space in waiting area could be seen at morning peak hours from 7.00 to 9.00 am and evening peak hours from 5.00 to 7.00pm (Figure1.1). An inadequate waiting space has tremendous negative effects on

passengers, who are waiting in that area, which results in delays and time loss. Moreover, it positions rushed passengers to fight over in order to catch a train.

Figure 1.1: Condition in waiting area at peak hour.

Apart from that, not only inadequate space causes delays and time loss for passengers, but also contributes to increased levels of discomfort that may be a health risk especially for elders and passengers with special needs.

On the other hand, high probability of increase in traffic is predicted yearly, that has similar characteristics to traffic volume in highways. Moreover, Kuala Lumpur has high level of population that reaches 6891 citizens per square kilometers (BANCI 2010). This level makes a city more crowded and busy in all places. This research questions future implications of such problems, whereby today's platforms cannot provide an adequate space for passenger.

1.3 Objectives of study

The purpose of this study is to satisfy the following objectives:

1. To determine parameter for ridership capacity analysis of peak hours at Rapid Kelana Jaya Line Station.
2. To determine Level of Service (LOS) of ridership at Rapid Kelana Jaya Line Station.

1.4 Scope of study

This research must focus on the following scopes to establish according to the objectives:

a) Kelana Jaya Line KL Sentral platform is chosen location for this research.
b) Passenger flow during the peak and non-peak hours are considered on this scope of study.
c) Data collection of the passenger volume is ranged within peaks and non-peaks hours, and they are 7.00 to 9.00 AM and 5.00 to 8.00 PM during weekdays.
d) Train passenger capacity and coach platform entrance factors are excluded.
e) Levels of Services (LOS) are addressed in literature review according to the type of simulation methodology.

1.5 Significance of Research

In this research are focused on the capacity analysis of ridership in order to observe and analyse passenger flow during peak and non-peak hours at train stations and also to estimate the Levels of Services (LOS) on station platform.

This research will be enable transit operators, transport planners and building designers to provide suitable walkway area to meet passenger personal space demand. This is essential in providing sufficient space for passengers that are waiting for transit services. Additionally, to prevent crowding at the platform, this could present safety hazards to the users, especially in the case of an accident.

Besides that, this research can be used as reference for future studies to further investigate this area. In order to improve the quality of service on train stations, further studies on the level of service of passenger and on other factors are essentially required.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this literature review chapter, literature study has been carried out based on previous studies and literature to get more understanding regarding the study project. Transportation is a transport or vehicles that allow an item, object or person to move from one place to another reference. Transportation is very important from the early time until now. But the type of transportation have being improve from time to time. In early time, we had use animals such as bull, buffalo, camel, donkey, horses and many more to move. Later on, there are many types of transportation have been created such as bike, boats, ferry, cars, trains and aeroplanes.

Public transportation in the 21st century is on the move, as more and more Americans are discovering the benefits of travelling by buses, trains, subways, trolleys and ferries. In 2005, Americans took 9.7 billion trips on public transportation which is 15 times the number of trips they took on domestic airlines. The public transport ridership increased by 25 percent from 1995 to 2005. Currently there are more than 6400 providers of public and community transportation offering Americans freedom, opportunity and the choice to travel by means other than a car.

As noted in chapter 1, the increase in a number of populations day by day, make the building compact and cramp or known as crowding. Therefore, The second part of this chapter will discuss the behaviour of the pedestrian and factor that will be affecting the pedestrian behaviour while moving. Whereas the latter part of this chapter describes the Level of Service (LOS) and crowding topics.

2.2 Transit Capacity

Transit capacity deals with the movement of both people and vehicles. It is defined as the number of people that can be carried in a given time period under specified operating conditions without unreasonable delay or hazard and with reasonable certainty.

Capacity is a technical concept that is of considerable interest to operators, planners and service designers. There are two useful capacity concepts which is stationary capacity and flow capacity. Scheduled transit services are characterized by customer waiting at boarding areas and traveling in discrete vehicles along predetermined paths. The waiting area and the vehicle itself each have a stationary capacity measured in persons per unit of area. Transit services also have a flow capacity which is the number of passengers that can be transported across a point of the transportation system per unit of time. While this is usually thought of as the number of total customers per transit line per direction per hour, flow capacity can be measured for other elements of the system including corridors, fare turnstiles, stairs, elevators and escalators.

2.3 Factors Influencing Capacity

The capacity of a transit line varies along a route. Limitations may occur along locations between stops (way capacity), at stations and terminals (station capacity) or at critical intersections or junctions where way capacity may be reduced (junction capacity). In most cases, station capacity is the criticalThe capacity of a transit line varies along a

route. Limitations may occur along locations between stops (way capacity), at stations and terminals (station capacity) or at critical intersections or junctions where way capacity may be reduced (junction capacity). In most cases, station capacity is the critical constraint. In some stations, junctions near stations may further reduce capacity.

The key factors which influence capacity include the following:

- The type of right-of-way (interrupted flows vs. uninterrupted flows),
- The number of movement channels available (lanes, tracks, loading positions, etc.),
- The minimum possible headway or time spacing between successive transportation vehicles,
- Impediments to movement along the transit line such as complex street intersections and "flat" rail junctions,
- The maximum number of vehicles per transit unit (buses or rail cars),
- Operating practices of the transit agency pertaining to service frequencies and passenger loading standards, and
- Long dwell times at busy stops resulting from concentrated passenger boarding and alighting, on-vehicle fare collection and limited door space on vehicles

2.4 Ridership

Unlinked passenger trips are the number of times passengers board public transportation vehicles. Passengers are counted each time they board vehicles no matter how many vehicles they use to travel from their origin to their destination and regardless of whether they pay a fare, use a pass or transfer, ride for free, or pay in some other way. A person riding only one vehicle from origin to destination takes one unlinked passenger trip and a person who transfers to a second vehicle takes two unlinked passenger trips, meanwhile a person who transfers to a third vehicle takes three unlinked passenger trips. It also called boardings.

2.4.1 Modes and Abbreviations

In railway industry, there are many type mode and abbreviations of railway for example commuter rail, heavy rail, light rail and monorail. In every mode, it has different definition and the system that run for every mode also different each other's.

2.4.1.1 Commuter Rail

Commuter Rail is a mode of transit service (also called metropolitan rail, regional rail, or suburban rail) characterized by an electric or diesel propelled railway for urban passenger train service consisting of local short distance travel operating between a central city and adjacent suburbs. Service must be operated on a regular basis by or under contract with a transit operator for transporting passengers within urbanized areas, or between urbanized areas and outlying areas. Such rail service, using either locomotive hauled or self-propelled railroad passenger cars, is generally characterized by multi-trip tickets, specific station to station fares, railroad employment practices and usually only one or two stations in the central business district. Intercity rail service is excluded, except for that portion of such service that is operated by or under contract with a public transit agency for predominantly commuter services. Most service is provided on routes of current or former freight railroads.

2.4.1.2 Heavy Rail

Heavy Rail is a mode of transit service (also called metro, subway, rapid transit, or rapid rail) operating on an electric railway with the capacity for a heavy volume of traffic. It is characterized by high speed and rapid acceleration passenger rail cars operating singly or in multi-car trains on fixed rails. There are separate rights-of-way from which all other vehicular and foot traffic are excluded and also sophisticated signalling, and high platform loading.

2.4.1.3 Light Rail

Light Rail is a mode of transit service (also called streetcar, tramway, or trolley) operating passenger rail cars singly (or in short, usually two-car or three-car, trains) on fixed rails in right-of-way that is often separated from other traffic for part or much of the way. Light rail vehicles are typically driven electrically with power being drawn from an overhead electric line via a trolley or a pantograph which driven by an operator on board the vehicle and may have either high platform loading or low-level boarding using steps.

2.4.1.4 Monorail

Monorail is an electric railway of guided transit vehicles operating singly or in multi-car trains. The vehicles are suspended from or straddle a guideway formed by a single beam, rail, or tube.

2.5 Ridership Capacity

The previous discussion illustrated computational methods for train capacity in trains per track per hour and the vehicle capacity in persons per train car. The ridership capacity is computed as the product of the train capacity and vehicle capacity adjusted by the peak hour factor:

$$P = TV(PHF) = 36\ V(PHF) \qquad (2.1)$$

Where,

T = track capacity in trains per hour

V = train capacity

PHF = peak hour factor

2.5.1 Peak Hour Factor

According to the Transit Capacity and Quality of Service Manual (TCQSM) it was tabulates peak hour factor observed on various North American rail system inn mid-1990s. There are the defaults factors for certain type of rail which is:

i. Heavy rail: 0.80
ii. Light rail: 0.75
iii. Commuter rail: 0.60

2.5.2 Train capacity

In Kelana Jaya Line there two type of project which the previous and additional project. For previous it refers to the Mildlife Refurbishment Project (MLR) and the additional it refers to Kuala Lumpur Additional Vehicles Project (KLAV). According to the Land Public Transport Commission train capacity for Kelana Jaya Line was tabulate as shown in table 2.1:

Table 2.1: Train Capacity

No.	Description	MLR			KLAV		
		A/B Car	T1/T2 Car	Total	A/B Car	T1/T2 Car	Total
1.	Seated Capacity (AW1)	32	32	128	31	29	120
2.	Peak Load (AW3) @ 4pass/m^2	185	185	740	192	200	784
3.	Crush Load (AW4) @ 6pass/m^2	236	236	1416	245	257	1506

2.6 Factors Affecting Pedestrian Flow

There are many factors affecting pedestrian flow which should be paid attention during model development and parameter calibration.

2.6.1 Mean Walking Speed

Mean walking speed is the fundamental component of pedestrian flow model and free flow speed indicates or to show the average movement speed of pedestrians when they are not hindered or been obstruct by other pedestrians or other obstacle, walking under normal condition. However, it requires extensive data collection for calibration as the walking speed is subject to many factors such as area of walking space, mood, weather and few other factors (Xu.,*et al.* 2010). Figure 2.1 shows examples of factors which may affect walking speed.

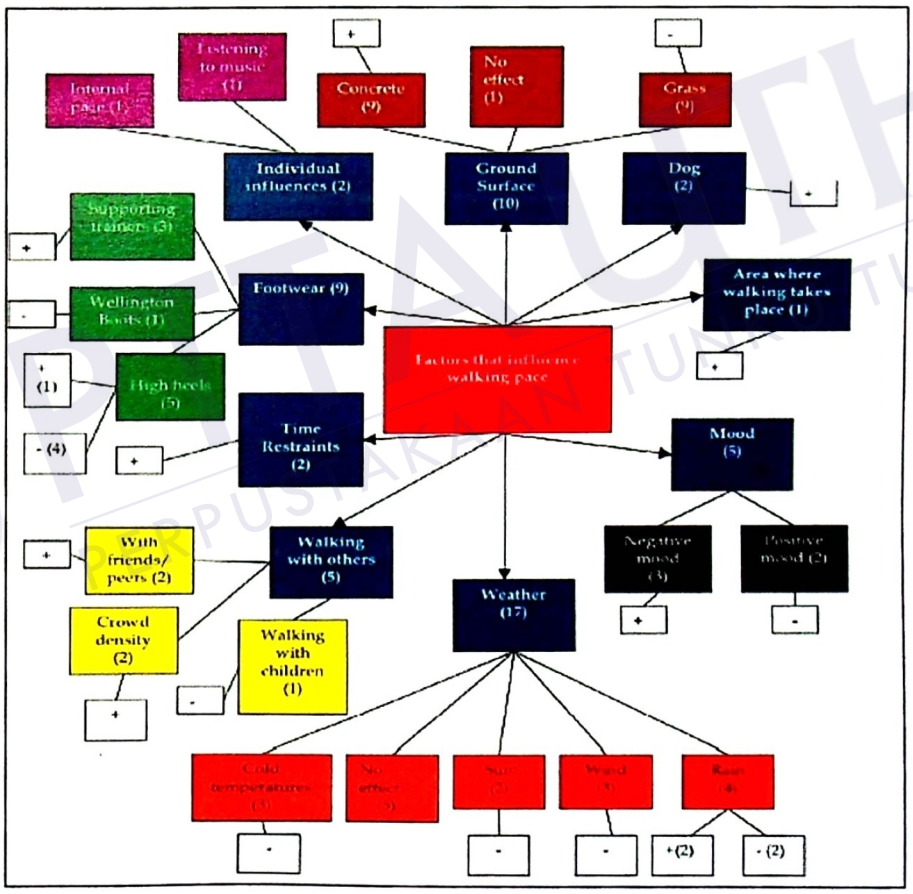

Figure 2.1: Factors affecting free flow speed, (Taylor et al., 2010)

Pedestrian walking speed determines the flow rate or capacity of a walking facility. The relationship of pedestrian flow rate and walking speed are as flowing:

$$q = N/ t*w \quad (2.2)$$

as

$$v = d/t \text{ and } p = N/ w*d \quad (2.3)$$

therefore,

$$q = p*v \quad (2.4)$$

where

q = pedestrian flow rate

v = average walking speed of pedestrians

ρ = density of pedestrian in the walking facility

N = no. of pedestrians passed through the walking facility

t = time for a pedestrian to pass through the walking facility

w = width of the walking facility

l = length of the walking facility

Thus, the walking speed of pedestrians is directly proportional to the pedestrian flow rate. In other words, the faster is the walking speed of pedestrians, the larger is the pedestrian flow rate or capacity of the walking facilities.

Table 2.2: Pedestrian flow rate under different circumstances

Source	**Max. Flow Rate (person/min/m)**	**Critical Density (person/m2)**	**Location**
Fruin (1971)	72	1.08	United States
Daly et al. (1991)	86		London Underground, UK
Lam and Cheung (1999)	92		Passageway in MTR Station, Hong Kong
Lam et al. (2000)	81.40	2.63	Outdoor Commercial

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