PROPOSING DEMAND MEET CAPACITY WAITING AREA FOR PASSENGER AT STATION STAR LRT MASJID JAMEK KUALA LUMPUR

MUHAMMAD AKMAL BIN YAAKOB

Thesis submitted in fulfilment of requirements for the award of degree of Engineering in Civil Engineering

Faculty of Civil Engineering
UNIVERSITI MALAYSIA PAHANG

JUNE 2013

ABSTRACT

Level of Service (LOS) is a quality of measurement control that characterizes an operational condition. It's commonly used in measure traffic condition roadside to determine the level of effectiveness. However, a LOS measure for waiting area is not well developed until now. The primary objective of this study is to determine the level-of-service of the pedestrian walkway at Station STAR LRT Masjid Jamek Kuala Lumpur, in order to understand its current operational conditions. This research may adapt from the methodology of and Transit Capacity and Quality of Service Manual (TCQSM) to compute LOS of passenger. The results showed that the waiting area service in Ampang/Sri Petaling line at LOS F on weekdays and LOS D on weekend. Thus, the operational condition of the walkway is poor condition and a waiting area cannot meet a demand capacity for passenger. Therefore, new design walkway width need to define to meet the purpose on desired level of service.

ABSTRAK

"Level of Service" (LOS) adalah kualiti kawalan ukuran yang menyifatkan keadaan operasi. Ia biasanya digunakan dalam keadaan lalu lintas tepi jalan ukuran untuk menentukan tahap keberkesanan. Walau bagaimanapun, langkah tahap perkhidmatan bagi kawasan menunggu tidak dibangunkan dengan baik sehingga sekarang. Objektif utama kajian ini adalah untuk menentukan tahap perkhidmatan laluan pejalan kaki di Stesen STAR LRT Masjid Jamek Kuala Lumpur dan memahami keadaan semasa operasi. Kajian ini di kaji dan di ambil dari metodologi "Transit Capacity and Quality of Service Manual" (TCQSM) untuk mengira LOS penumpang. Hasil kajian menunjukkan bahawa perkhidmatan kawasan menunggu di aliran Ampang / Sri Petaling di LOS F pada hari biasa dan LOS D pada hujung minggu. Oleh itu, keadaan operasi laluan adalah dalam keadaan sesak dan kawasan menunggu tidak dapat memenuhi permintaan kapasiti untuk para penumpang. Jesteru itu, ruangan menunggu baru perlu direka semula untuk memenuhi pada tahap yang dikehendaki perkhidmatan di Stesen LRT Masjid Jamek Kuala Lumpur.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

W_E	Effective walkway width
W_T	Total walkway width
W_O	Sum of widths and shy distances from obstruction on walkway width
V_{hour}	Total Pedestrian Volume Per Hour
V_{15}	Total Pedestrian Volume Per Minute

LIST OF ABBREVIATIONS

LOS	Level of Service
TCQSM	Transit Capacity and Quality of Service manual
STAR	Sistem Transit Aliran Ringan
LRT	Light Rail Station

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Level of Service (LOS) is a measure used by traffic engineers to determine the effectiveness of elements of transportation. The function of LOS is to analyze highway or traffic by categorizing traffic flow with corresponding safe driving conditions (Wikipedia, n.d). The concept not only apply to traffic vehicle in highway and road, but also been applied to other application such as intersection, transit and solid waste control..

LOS of pedestrian facilities may be featured in this research. Different from other LOS such as roadway and intersection, the concept of LOS still same which have 6 level of LOS, from A to F. A difference of LOS of pedestrian is comfortable and walks ability of person to each person. The calculation may refer to Highway Capacity Manual, which more depend on capacity and space movement.

The study area of this research at Masjid Jamek LRT Station, Kuala Lumpur. This station is one of the most passenger uses which interchange station between two of RapidKL's (LRT) lines, namely the Ampang Line (formerly STAR LRT) and the Kelana Jaya Line (PUTRA LRT) (Wikipedia, n.d).

1.2 PROBLEM STATEMENT

Although the train frequency cycle average 3 minutes based on MyRapid Train Frequency during peak hour, the waiting area cannot overcome an adequate space for passenger. A peak hour in train frequency may refer to Appendix A1 which a less minute is called a peak, hour. We can see inadequate space in waiting area at the peak hour which in the morning (7.00 – 9.00 am) and in the evening (5.00 – 8.00 pm). An inadequate space will give more problems to passengers who are waiting in waiting area which cause loss and delay time. Moreover than that, a passenger must fight over to enter a train.

Figure 1.1: Condition in waiting area at peak hour

Figure 1.2: Condition in waiting area at peak hour

Apart from that, not only inadequate space will cause loss and delay time to passenger, but will contribute discomfort and health risk especially for an elders and disabilities person. Thus, and elder and disabilities person may be displaced to enter the train although they have special seat in train, and have lift in the station.

Like traffic volume, in highway, an increase of traffic may happen in every year. A city of Kuala Lumpur with highest density people which has 6891 citizen for square kilometers (BANCI 2010) make a city more crowded and busy in all place. What will happen in future if today also cannot overcome an adequate space for passenger. Thus, in this research also may search a new waiting area at Station STAR LRT Masjid Jamek for future development.

1.3 OBJECTIVE

i. To propose new suitable walkway with of the waiting area to qualify meet demand capacity of passenger for future development
ii. To determine the Level of Service (LOS) in waiting area to meet the suitable quality of service.

1.4 SCOPE OF STUDY

In this research, it may concentrate only on Level of Service in waiting area at Station STAR LRT Masjid Jamek, Kuala Lumpur. Apart from that, this research also may concentrate on walkway width in waiting area. Other factor such as passenger capacity in the train, and coach to enter the train may not include in this research. Further studies on the level of service of passenger on other factors should be done by other researcher in the future to better development in station condition, section classification, slenderness and compressive capacity.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter may explain the definitions of capacity and level of service (LOS) for further understanding as well as discusses the concept of capacity and the relationship between capacity and level of services. Apart from that, this chapter also reviews the use level of service from past research in various fields such as LOS at airport, bus terminal, and pedestrian.

The levels of service (LOS) for pedestrian facilities are affected by several factors. The differences of criteria for pedestrians LOS commonly exist in different countries, even within the same country at different development periods. For example, the pedestrian space of LOS A provided by America is 3.7 times more than that provided by Japan, and the American criteria in 1985 is quite different from that in 1971 (HCM 2000, 2000).

2.2 LEVEL OF SERVICE

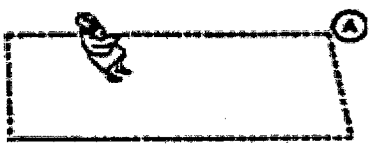
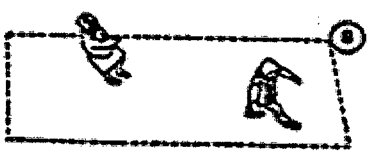
Level of Service (LOS) is a method by which a transportation facility's performance is evaluated. In general term, it is a quantitive measure describing the operational condition of the facility's stream and the user's perception of those conditions within area of evaluation (Klodzinski, 2001). Thus,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

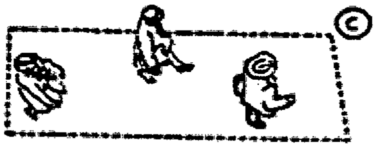
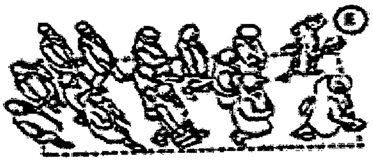
Other than that, Highway Capacity Manual defines level of service as qualitative measures that characterize operational conditions within a traffic stream and their perception by motorists and passengers. From this point, traffic stream by vehicle and passenger may create a form of traffic conditions which we can categorize a condition by qualitative measure.

2.3 LEVEL OF SERVICE STAGE

From TCQSM, there are six stages in Level of Service that are defined for capacity analysis. The stage which start letter from LOS A which representing the best range until LOS F which representing the worst range. The description of Level of Service stage may explain in Table 2.1

Table 2.1 : Level of Service Stage

Diagram	Description
	<u>**Level of Service A**</u> Average pedestrian area occupancy : ≥ $35ft^2/p$ Average speed : 260ft/min Description : Walking speeds freely selected; conflicts with other pedestrians unlikely
	<u>**Level of Service B**</u> Average pedestrian area occupancy : 25 - $35ft^2/p$ Average speed : 250ft/min Description : Walking speeds freely selected; pedestrian respond to presence of others

	**<u>Level of Service C</u>** Average pedestrian area occupancy : 15 - 25ft^2/p Average speed : 240ft/min Description : Walking speeds freely selected; passing is possible in unidirectional streams; minor conflicts for reserve or cross movement
	**<u>Level of Service D</u>** Average pedestrian area occupancy : 10 - 15ft^2/p Average speed : 225ft/min Description : Freedom to select walking speed and pass others is restricted; high probabilities of conflicts for reverse or cross movements
	**<u>Level of Service E</u>** Average pedestrian area occupancy : 5 - 10ft^2/p Average speed : 150ft/min Description : Walking speeds and passing ability are restricted for all pedestrians; forward movement is possible only by shuffling; reverse or cross movements are possible only with extreme difficulty; volumes approach limit of walking capacity
	**<u>Level of Service F</u>** Average pedestrian area occupancy : < 5ft^2/p Average speed : < 150ft/min Description : Walking speeds are severely restricted; frequent, unavoidable contacts

	with others; reverse or cross movements are virtually impossible; flow is possible and unstable

Source :TCQSM 2003

2.4 CONCEPT OF CAPACITY

In the manual practical capacity was define as “ the maximum number of vehicles that could pass a given point without the traffic density being so great to cause unreasonable delay, hazard or restriction to the driver’s freedom to manoeuvre under the prevailing road conditions”

The capacities of passenger are different from highway capacity. The capacity of highway is depend on size of vehicle such as normal vehicle, heavy vehicle, and motorcycle, and traffic flow at intersection or junction. Different from highway capacity, passenger capacity are depend on the operating policy of the transit agency, which control services frequencies like rail timing , and allowable passenger loading.

2.5 TYPE OF LEVEL SERVICE

In this research, the concept of level of service is same but different place in research. In past research, they conduct their research Level of Service at bus terminal and terminal airport. Level of Service of pedestrian and facilities is used by past researchers to evaluate their research. Furthermore, their objective may same which include in term of capacity relationship.

2.5.1 Bus level of service

From the findings of the study, it is noted that the inter-person spacing, density, walking spacing and the facilities in the bus terminal affect the operating level of service of the walkway. Pedestrian space is the primary factor that will affect the level of comfort of pedestrian. (Hisham, 2010). Apart from that, passenger way finding is an important aspect in airport terminal layout design and planning. To achieve successful passenger orientation, an evaluation of the ease of passenger orientation in the terminal building is necessary and contributory.

2.5.2 Airport level of service

Passenger way finding is an important aspect in airport terminal layout and design. To achieve successful passenger orientation, an evaluation of the ease of passenger orientation in the terminal building is necessary and contributory, (Mei-Ling Tam, William H.K. Lam, 2003).

2.6 TYPE OF STATION

The type of station may provide different service need in waiting area at every station. Some of examples that may affect a service are different of length of station, thus it will affect a level of service. The type of station at below is especially for train only.

2.6.1 Light Rail Station

Light rail stations are ordinarily 180 to 400 ft (55 to 120m) long. Different platform configurations are possible, including center, side, or split on opposite sides of an intersection. Stations may be on-street, off-street, along a railroad right-of-way, or on a transit mall. High and low platforms have been used, although the trend in recent years has been the increasing use of an intermediate height for platforms that is approximately 14 in. (0.35m) above the top of the rail to match the floor height of low-floor light rail vehicles. Light rail stations usually include canopies over part of the platform, limited seating, and ticket vending machines. Fare collection on light rail systems is typically by the proof-of-payment system, so stations do not have fare gates or barriers. (TCQSM, 2003)

2.6.2 Heavy Rail Station

Heavy rail stations are generally 600 to 800 ft (180 to 240 m) long. Stations on heavy rail, rapid transit, or metro systems are usually more elaborate than light rail or many commuter rail stations. Due to the presence of third-rail power in many of these systems, and to prevent passengers from entering the trackway, these stations always have high-level platforms. Stations are most often located underground or elevated, and frequently have intermediate mezzanine levels between the street and platform levels. Both center or side platform configurations are used, and some stations have more than two tracks. Special configurations allow cross-platform transfers or reflect location-specific conditions. Most heavy rail stations have fare control arrays and enclosed paid zones, although some European systems use proof-of- payment systems. (TCQSM, 2003)

2.6.3 Commuter Rail Stations

Platforms in these stations can range from 300 to more than 1000 ft (90 to over 300m) long. Commuter rail stations range from suburban locations with one or two platforms, limited service, and relatively small passenger volumes to major urban terminals with many tracks and platforms offering a variety of local and express services to various destinations. These stations may use either center or side platforms or a combination of both in larger terminals. Higher-volume systems tend to use high platforms. In some cases, passenger and freight trains share the same tracks. Horizontal clearance requirements for freight cars may be greater than for passenger equipment and thus can impact the placement of platform features, such as wheelchair ramps. (TCQSM,2003)

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter review the methodology of this research which includes method and technique that may apply to get data collection and data analysis. The method of analysis Level of Service consists of 3 phases which are planning, analysis and design phase.

In planning phase, a visual condition survey and passenger count in Station STAR LRT Masjid Jamek, Kuala Lumpur may be apply to get data collection before go to next phase. Next, in second phase which analysis phase, will analysis the data collection which get from first phase with method from TCQSM. For final phase which is design phase to propose new suitable width for passenger waiting area at Station STAR LRT Masjid Jamek. A third phase will also adapted the methodology from TCQSM

3.2 FLOW CHART METHODOLOGY

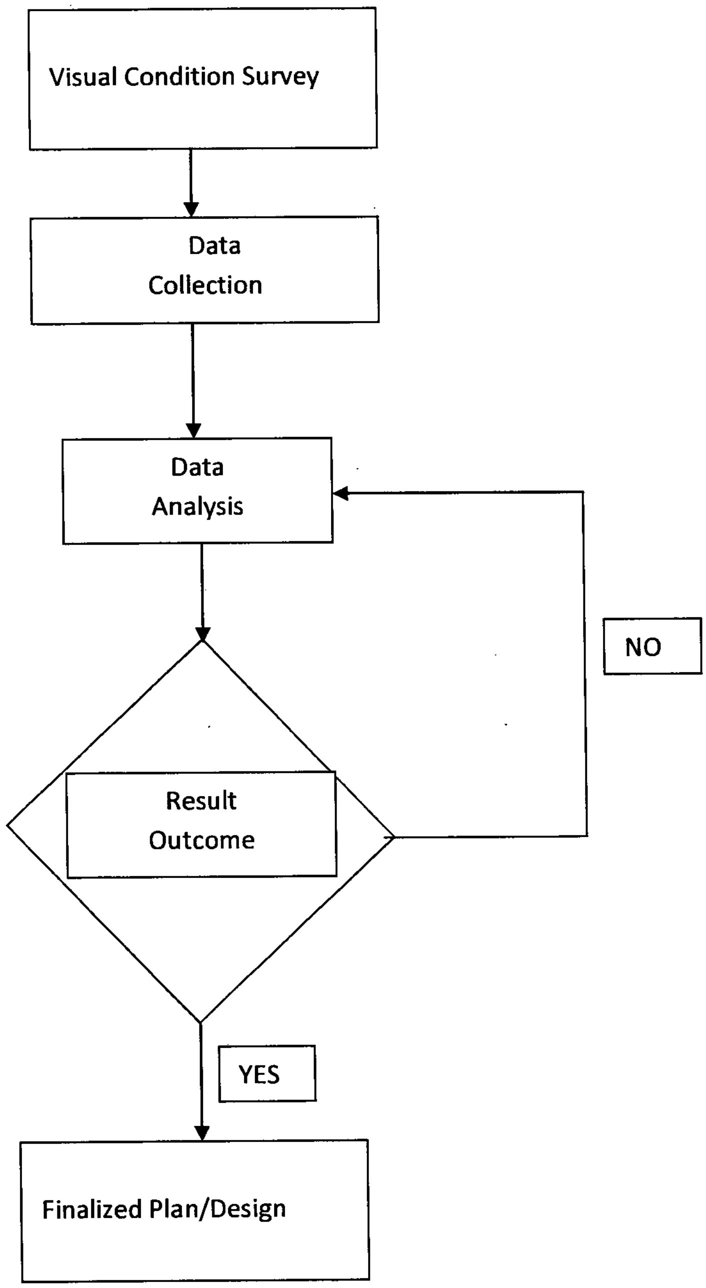


Figure 3.1: Flow Chart Methodology

3.3 PHASE 1 : PLANNING

This phase are followed with sub objective which to determine peak hour volume of passenger and the factors affecting passenger level of service. Apart from that, this stage involves the site studies to understand the concept of level of service, capacity, a circulation between queuing and waiting area. A visual condition survey may be conducted as to know what have in existing site waiting area.

A preliminary Condition Survey entails the review of existing documentation such as construction drawings, specifications, reports and calculations (James A. Kern, n.d). A visual condition survey may search into a capacity of waiting area. An area of waiting area may be calculated from a length and area of waiting area.

A passenger count may be conducted to determine the volume of passenger. A passenger count will be done manually in two days which are weekdays, and weekend.

3.4 PHASE 2 : ANALYSIS

A second phase also follow the sub-objective which to determine the Level of Service (LOS) in waiting area to meet the suitable quality of service. From the collection data from phase 1, a data will be analyzed through appropriate method. The analysis will be more onward to relationships between capacity and volume. The method of calculation may refer from TCQSM Manual. Table below are some important formula which may use to determine LOS. From data collection, the level of service for the waiting area can be classified. Only the peak hour volume of pedestrian for these three different times is selected for the LOS calculation.

Table 3.1: LOS Steps Calculation

Time	(Refer to time data collected)
Existing Walkway Width	(Refer to site location)
Area of the effective walkway width	(Refer to site location)

Peak hour pedestrian volume, V_p	(Refer from Table 4.1, Table 4.2, Table 4.3, Table 4.4)
Average Pedestrian Area	$\frac{\text{Area of the effective walkway width } (m^2)}{\text{Peak hour pedestrian volume } (V_p)}$

After average pedestrian area is determine, the type of Level of Service may obtain from table below

Table 3.2 : Pedestrian Level of Service in Walkway

LOS	Pedestrian Space (m^2)	Expected Flows and Speeds		
		Avg. Speed, S (m/min)	Flow per unit width, v (p/m/min)	v/c
A	≥3.3	79	0 – 23	0.0 – 0.3
B	2.3 – 3.3	76	23 – 33	0.3 – 0.4
C	1.4 – 2.3	73	33 – 49	0.4 – 0.6
D	0.9 – 1.4	69	49 – 66	0.6 – 0.8
E	0.5 – 0.9	46	66 – 82	0.8 – 1.0
F	<0.5	<46	Variable	Variable

Source :TCQSM 2003

3.5 PHASE 3 : DESIGN

In the last phase, this phase focus to our main objective which to proposing a suitable width of the waiting area to qualify the demand meet capacity for passenger. After determine the LOS in term of capacity and volume, the objective for this research may be applied with design new waiting area to qualify the demand meet capacity for passenger for future development at Masjid Jamek, LRT Station, Kuala Lumpur. To propose new suitable width, there are some procedures that may take based on maintaining a desirable pedestrian LOS. An evaluation procedure below is taken from TCQSM.

3.5.1 Determining Effective Walkway With

i. Based on the desired LOS, choose the maximum pedestrian flow rate (p/ft/min, or p/m/min) from Table 2.6
ii. Estimate the peak 15-minutes pedestrian demand for the walkway
iii. Multiply by an appropriate adjustment factor to account for pedestrian who used additional space, such as wheelchair users.
iv. Computer the design pedestrian flow (p/min) by dividing the 15-minutes demand by 15
v. Computed the required effective width of walkway (in feet or meters) by dividing the design pedestrian flow by the maximum pedestrian flow rate.
vi. Compute the total width of walkway (in feet or meters) by adding 3ft (1m), with an 18-in (0.5m) buffer on each side to the effective width walkway.

3.5.2 Determining Walkway Capacity

i. Compute the effective width of walkway (ft or m) by subtracting 3 ft (1m) or other appropriate buffer zones from the total walkway width.
ii. Compute the design pedestrian flow (p/min) by multiplying the effective width of walkway by 25p/ft/min (82p/m/min)
iii. Adjust for special pedestrian characteristic, as appropriate.
iv. Compute the pedestrian capacity (p/h) by multiplying the design pedestrian flow by 6