

ANALYSIS OF PEDESTRIAN PATH WIDTH REQUIREMENTS IN THE MANUKAN LOR ROAD AREA, SURABAYA CITY

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ABSTRACT

The commercial area on Manukan Lor Street in Surabaya, known for high traffic volumes, lacks adequate pedestrian pathways, creating safety hazards and traffic disruptions. This study rigorously analyzes pedestrian traffic patterns to establish the optimal pathway width needed to ensure safety and enhance infrastructure efficiency. Unlike previous studies, this research assesses the impact of pathway width adjustments on pedestrian flow and safety in this densely populated commercial zone. Using empirical data from direct observations and adhering to the "Sidewalk Planning Guidebook No.007/T/BNKT/1990 Directorate General of Highways," "Guidebook for Building Construction Materials and Civil Engineering Ministry of PUPR No.02/SE/M/2018," and the "Indonesian Road Capacity Guidebook 2023 (PKJI 2023)," this study provides a comprehensive evaluation of pedestrian dynamics. The findings suggest that a pedestrian pathway width of 1.5 meters, resulting in a service level A with low-level side obstacles, significantly enhances pedestrian safety. This width maintains a degree of saturation (Dj) increase of 0.026, ensuring traffic flow remains stable and controllable within service level category C.

Keywords: Pedestrian Width; Characteristics; Road Performance.

1. Introduction

Complex problems due to the ever-evolving transportation, such as congestion that causes wasteful use of fuel, air and noise pollution which has an impact on reducing the quality of life caused by vehicle exhaust emissions, as well as the increasing occurrence of accidents on the highway [14]. Surabaya is the second largest city in Indonesia after Jakarta, it is one of the economic centers in Indonesia, and many companies are located in this city. These things make it attractive for people to immigrate to the city of Surabaya. This will affect the availability of facilities to serve all activities, one of which is pedestrian facilities. Walking is the cheapest, easiest, and healthiest mode of transportation, to meet a person's mobility and movement needs, walking can be a simple solution.

The commercial area on Manukan Lor Street is one of the places in the city of Surabaya that currently has quite heavy traffic. Many shops are selling various needs, such as electronic goods and household necessities, as well as educational places, namely Dorowati Middle School. The problem in this area is that there is no special pedestrian /pedestrian route available so it can endanger pedestrians, apart from that it can also disrupt the activity of traffic vehicles. Parking facilities are a means of supporting transportation and vehicles[16]. This facility is at the destination that must be provided. This is very important in the scope of the transportation system. At night many street vendors use the sidewalk, as a result, pedestrians in this area do not use the sidewalk for activities but use the shoulder of the main road. This can reduce comfort for pedestrians and the performance of the road itself. Infrastructure and facilities & pedestrian networks are facilities provided along the pedestrian network to ensure the safety and comfort of pedestrians [4]. Previous research has primarily focused on generic pedestrian facility needs without addressing the nuanced demands of

pedestrian traffic in commercial areas like Manukan Lor Street. This study addresses this gap by focusing on pedestrian characteristics specific to high-traffic commercial zones and the effects of infrastructure improvements on these characteristics."

2. Material and Method

- a) Data analysis is based on survey results, by calculating the volume of pedestrians during 13 hours of observation per 15 minutes. Then analyze the need for pedestrian paths, namely the width of the sidewalk according to the Sidewalk Planning Guidebook Number.007/T/BNKT/1990 Directorate General of Highways", "Guidebook for Building Construction Materials and Civil Engineering of the Ministry of PUPR number.02/SE/M/2018 Concerning Technical Planning for Pedestrian Facilities.
- b) Analysis of pedestrian respondents regarding security and safety on the road
- c) Data analysis is based on survey results, by calculating the average vehicle traffic volume for 13 hours with 15-minute observations then analyzed using the 2023 Indonesian Road Capacity Guidebook (PKJI 2023).

2.1. Data Type

Survey the volume and speed of pedestrians to determine the number of pedestrians using the road. The survey was carried out along Manukan Lor road from the jewelry shop to the Manukan Lor traditional Surya market. Survey of average vehicle volume and speed to determine the average daily traffic on this road section. The survey was carried out along Manukan Lor road from the jewelry shop to the Manukan Lor traditional Surya market. Questionnaire This questionnaire will be distributed to people who move around on foot in the road area. Below is the picture Map of research locations in the Jalan Manukan Lor area, Surabaya City



Figure 1. Map of research locations in the Jalan Manukan Lor area, Surabaya City

2.2. Survey Method

The research time is 13 hours on weekdays and 3 days off, namely Monday, Thursday, and Saturday starting at 07:00 - 20:00 WIB with a time division of 3 hours in the morning, 3 hours in the afternoon, and 3 hours in the evening. day.

2.3. Data analysis

1. The width of the sidewalk can be calculated using the following formula:

$$W = \frac{v}{35} + N \quad (2.1)$$

Where :

W = Width of the sidewalk (meters)

V = Planned/two-way pedestrian volume (people/meter/minute)

N = Additional width according to local conditions (m)

2. The width of the sidewalk must be able to serve the existing pedestrian volume. Existing sidewalks need to be reviewed. Capacity (width), condition, and use if pedestrians are using the vehicle traffic lane. It is recommended that sidewalks be planned with a service level as low as C.

Table 1. Sidewalk Service Levels

Service level	Module (m ² /person)	Volume (person/meter/minute)
A	≥3.25	≤23
B	2.30-3.25	23-33
C	1.40-2.30	33-50
D	0.90-1.40	50-66
E	0.45-0.90	66-82
F	≤0.45	≥82

Source: Sidewalk Planning Manual Number: 007/T/BNKT/1990,

Directorate General of Highways, Directorate of City Road Development

3. Capacity Calculation

Capacity is defined as the maximum flow through a point on the road that can be maintained per unit hour at certain conditions. For two-lane two-way roads, capacity is determined for two-way flows (a combination of two directions), but for roads with multiple lanes, flows are separated per direction, and capacity is determined per lane.

The equation for determining capacity is as follows:

$$C = C_0 \times FCl_j \times FCpa \times FChs \times FCuk \quad (2.3)$$

4. Degree of saturation (current/capacity)

The degree of saturation is calculated using current and capacity expressed in pcu/hour. The basic equation for determining the degree of saturation is as follows:

$$D_j = q/C \quad (2.4)$$

Where :

D_j = Degree of Saturation

Q = Traffic Flow

C = Capacity (pcu/hour)

5. Service level and road characteristics

Service level is a measure of road performance that is calculated based on the level of road users, speed, density, and obstacles that occur.

Table 2. Level of Service

Service level	Q/C	Related Operating Characteristics
A	0-0.20	Free flow, low volume and high speed, the driver can choose the desired speed
B	0.20-0.44	The flow is stable with little limitation by traffic. The driver can freely choose the speed
C	0.45-0.74	Steady flow speed can be controlled by traffic
D	0.75-0.8	Flow starts to become unstable, speed is low and varies, volume approaches capacity
E	0.85-1.00	Unstable flow, low and variable speed, volume approaching capacity

Service level	Q/C	Related Operating Characteristics
F	>1.00	Flow is blocked, jammed and traffic is in a stagnant condition

Source: Edward K. Morlok introductory book to Transportation Engineering and Planning, page 213

3. Result and Discussion

This research was carried out on Jalan Manukan Lor Surabaya starting from the jewelry shop to the Manukan Lor Traditional Surya market with a length of 800 meters and a road width of 6 meters. Data from a pedestrian questionnaire survey to determine the characteristics of pedestrians on Jalan Manukan Lor Surabaya.

3.1 Pedestrian Characteristics

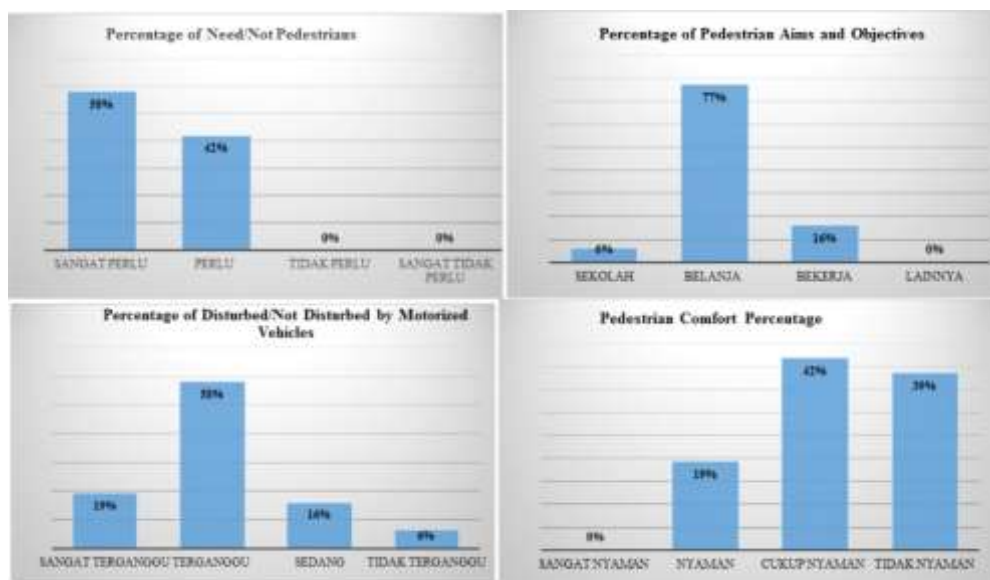


Figure 2. Pedestrian Percentage

The current width of pedestrian pathways is inadequate to handle the observed volume of pedestrian traffic, which reaches up to 66 people per 15 minutes during peak hours. Figure 2 illustrates the percentage distribution of pedestrian types, highlighting a significant proportion of pedestrians who are affected by the lack of proper pathways. Table 1 outlines the different levels of service for sidewalks and demonstrates that the existing width only achieves a service level of C, indicating a controlled but constrained flow of pedestrian traffic. The proposed width of 1.5 meters, as derived from empirical data and existing guidelines, is expected to elevate the service level to A, substantially enhancing pedestrian flow and safety.

3.2 Analysis of Effective Width Requirements for Pedestrian Paths

From the data from the observation survey at the location, it was obtained that the largest volume value was 66 people/15 minutes or 4.4 people/minute. So, to calculate the effective width of pedestrian paths, you can use equation (2.1).

$$W = 4,4/35 + 0.5 = 0.626 \text{ m}$$

The "N" value uses 0.5 because the pedestrian flow is <16 people/minute, namely 4.4 people/minute or includes low pedestrian generation.

When planning a pedestrian path, apart from calculating the effective width of the pedestrian path, it is also necessary to determine the dimensions for supporting facilities for the pedestrian path.

Determination of the dimensions of pedestrian path facilities can be seen in Table (2.4). Based on a maximum pedestrian flow of 35 people/minute/meter, then:

1. Required curb width = 0.15 m
2. Required facility path width = 0.6 m
3. Width of the front of the building = 0.15 m
4. effective width/calculation based on pedestrian flow = 0.626 m

So the total width of the pedestrian path required is:

$$L = 0.15 + 0.6 + 0.15 + 0.626$$

$$L = 1.526\text{m} \sim 1.5\text{m}$$

3.3 Performance of road sections before and after the presence of sidewalks

1. Capacity Before and After Sidewalks

The following is an example of calculating capacity on Jalan Manukan Lor before and after the planned sidewalk:

So, the capacity of the road in Manukan Lor on Monday before the planned sidewalk is:

$$\begin{aligned} C &= C_o \times FC_{lj} \times FC_{pa} \times FC_{hs} \times FC_{uk} \\ &= 2800 \times 0.87 \times 1.00 \times 1.00 \times 1.00 \\ &= 2436 \text{ pcu/hour} \end{aligned}$$

So, the capacity of the road in Manukan Lor on Monday after the planned sidewalk is installed:

$$\begin{aligned} C &= C_o \times FC_{lj} \times FC_{pa} \times FC_{hs} \times FC_{uk} \\ &= 2800 \times 0.87 \times 1.00 \times 0.95 \times 1.00 \\ &= 2314.2 \text{ pcu/hour} \end{aligned}$$

The results of the Manukan Lor road capacity calculation can be seen in Table 3 below:

Table 3. Capacity of The Manukan Lor Road, Surabaya, Indonesia

Time	Basic capacity	Adjustment Factor for capacity				Capacity (C) pcu/hour
	C _o	Path width FC _{LJ}	Directional divider FC _{PA}	Side obstacles FC _{HS}	City size FC _{UK}	
	pcu/hour	FC _{LJ}	FC _{PA}	FC _{HS}	FC _{UK}	
Monday before there are sidewalks	2800	0.87	1.00	1	1.00	2436
Thursday before there were sidewalks	2800	0.87	1.00	1	1.00	2436
Saturday before there were sidewalks	2800	0.87	1.00	1	1.00	2436
Monday after the sidewalk plans are in place	2800	0.87	1.00	0.95	1.00	2314.2
Thursday after the planned sidewalk	2800	0.87	1.00	0.95	1.00	2314.2
Saturday after the planned sidewalk	2800	0.87	1.00	0.95	1.00	2314.2

2. Degree of Saturation Before and After Sidewalks

The degree of saturation (DJ) is defined as the level of performance of the road segment being observed, a value between zero and one is the value of the degree of saturation to identify the quality of road performance, the following are the steps to determine the degree of saturation:

1. Determine traffic flow at peak hours obtained from the results of field surveys
2. Determine the road capacity obtained from calculations.
3. Calculate the degree of saturation using equation 2.4

The following is an analysis of the degree of saturation at the highest peak hours for Jalan Manukan Lor before and after the planned sidewalk:

Traffic volume (Q)

Monday, July 10 2023 = 1266.8 pcu/hour

Thursday, July 13 2023 = 1149.9 pcu/hour

Saturday, July 15 2023 = 1255.8 pcu/hour

Road capacity (C)

Before the planned sidewalk = 2436 pcu/hour

After the planned sidewalk = 2314.2 pcu/hour

1. Degree of saturation on Monday before the planned sidewalk:

$DJ = Q/C$

$DJ = 1266.8 / 2436$

$DJ = 0.520$

2. Degree of saturation on Thursday before the planned sidewalk:

$DJ = Q/C$

$DJ = 1149.9 / 2436$

$DJ = 0.472$

3. Degree of saturation on Saturday before the planned sidewalk:

$DJ = Q/C$

$DJ = 1255.8 / 2436$

$DJ = 0.516$

4. Degree of saturation on Monday after the planned sidewalk:

$DJ = Q/C$

$DJ = 1266.8 / 2314.2$

$DJ = 0.547$

5. Degree of saturation on Thursday after the planned sidewalk:

$DJ = Q/C$

$DJ = 1149.9 / 2314.2$

$DJ = 0.497$

6. Degree of saturation on Saturday after the planned sidewalk :

$DJ = Q/C$

$DJ = 1255.8 / 2314.2$

$DJ = 0.543$

The level of service on the Manukan Lor road itself is determined using the degree of saturation, so it is by Table 4 the level of service on Jalan Manukan Lor before and after the planned sidewalk is average in category C with a stable flow of speed that can be controlled by traffic.

Table 4. Level of Service

Service level	Q/C	Related Operating Characteristics
A	0-0.20	Free flow, low volume and high speed, the driver can choose the desired speed
B	0.20-0.44	The flow is stable with little limitation by traffic. The driver can freely choose the speed
C	0.45-0.74	Steady flow speed can be controlled by traffic
D	0.75-0.8	Flow starts to become unstable, speed is low and varies, volume approaches capacity
E	0.85-1.00	Unstable flow, low and variable speed, volume approaching capacity

F	>1.00	Flow is blocked, jammed and traffic is in a stagnant condition
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Source: Edward K Morlok, Introductory Book to Transportation Engineering and Planning, page 213

Service Level Indicators (ITP) on a road section show the overall condition of that road section. The level of service is determined based on quantitative values such as travel speed and other factors are determined based on quantitative values such as the driver's freedom to choose speed, degree of traffic obstruction, and comfort [15].

4. Conclusion

Based on observations and analysis on Jalan Manukan Lor, Surabaya City, the following conclusions were obtained: The characteristics of pedestrians on Jalan Manukan Lor are that 58% need a pedestrian path, 58% feel disturbed by motorized vehicles, 39% feel uncomfortable and 42% feel quite comfortable walking on Jalan Manukan Lor. The analysis results of the required width of pedestrian lanes on Jalan Manukan Lor are 2.93 pedestrians/meter/minute, namely 1.5 m wide with the level of service obtained is category A, and includes Low-level side barriers. The results of the peak hour volume of traffic flow on Jalan Manukan Lor on Monday at 17:30-18:30 were 1266.8 pcu/hour, on Thursday at 07:00-08:00 it was 1149.9 pcu/hour, and on Saturday at 18:15-19:15 as much as 1255.8 pcu/hour. The value of the degree of saturation based on the analysis results on Jalan Manukan Lor on Monday before the planned sidewalk was 0.520, on Thursday 0.472. Saturday it was 0.516, while for the degree of saturation after the planned sidewalk on Monday was 0.547, on Thursday 0.497, and finally on Saturday it was 0.543, with an average increase in value (Dj) of 0.026 but still in service level category C with a stable flow speed that can be controlled by traffic.

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