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Analysis Of Effectiveness Of Pavement Infrastructure (Case Study: Jl. Ahmad Yani Pontianak)

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Abstract

This study aimed to determine the effectiveness of pedestrian paths (sidewalks) in the Pontianak Selatan District, precisely on Jalan Ahmad Yani. The sidewalk as a pedestrian path is a space for pedestrians that functions as a means to protect pedestrians from the dangers that come from vehicles using the road. The method used is the survey method and questionnaire method. The data analysis method (Highway Capacity Manual, 1985) is used to obtain pedestrian characteristics.

Analysis of survey data used the Likert Scale method to obtain the level of pedestrian comfort and safety based on respondents' perceptions. The results of calculating the effectiveness of the sidewalks on Jalan Ahmad Yani obtained for zones A, B, and C are 17.35 m2/person, 7.75 m^2/person, and 30.39 m2/person. Based on the calculation of the pedestrian characteristics of the three road sections, the pedestrian path service level is obtained with standard A or LOS A.

The results from respondents obtained 11 good categories and two suitable enough types based on the calculation of the percentage of comfort level categories. The level of data reliability reached 0.853 based on SPSS statistics 2016. The results of this study indicate that the pedestrian path (sidewalk) is an excellent facility for pedestrians to exercise and relax in Pontianak Selatan District.

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1. Introduction

Track pedestrian is an essential infrastructure for pedestrians; the design must be done as well as possible for pedestrians to feel safe and conveniently through the lane(Sanjaya et al., 2017). However, the existence of pedestrian facilities has yet to meet the needs in terms of quantity or standards set (Uak, 2020).

The road network development in Kota Pontianak, especially in the Pontianak Selatan District, has impacted the construction sector's growth on these roads. The effects of development, such as shopping areas, shopping centers, offices, markets, campuses, housing, campuses, and others, affect the activities of road users, be it vehicle activity or walking to meet their needs (Rafiemanzelat et al., 2017). Because of this, it is necessary to analyze the pedestrian path market to increase pedestrians' security and safety in the Pontianak Selatan District. The following objectives are expected in this study:

a. Knowing the need for the vast dimensions of pedestrian paths based on the volume of pedestrians on Jalan Ahmad Yani Pontianak
b. Knowing the characteristics of pedestrians and the relationship between pedestrian movement variables.
c. Knowing the level of service and the level of comfort and safety of pedestrians.

As for the benefits of this research, it can be used as input for related parties in improving traffic services, and this research is expected to be a reference for other writers in the future.

2. Material and Methods

2.1 Theoretical Frame Work

Planning urban spaces that support sustainable practices requires new methods of analysis and structure (Tanan & Suprayoga, 2015; Agustin, 2017). An appropriate pedestrian network can significantly impact the goals of sustainable urban development (Rafiemanzelat, et al., 207) including facilitating sustainable mobility and enhancing pedestrian friendliness (Suminar & Sari, 2017). Using the sidewalk as a pedestrian path prevents pedestrians from being exposed to the risks of vehicles utilizing the road (Susetyaningsih et al., 2019). This investigation aimed to determine the effectiveness of pedestrian paths (sidewalks) in the Pontianak Selatan District, particularly on Jalan Ahmad Yani. The Highway Capacity Manual, 1985, is used to analyze pedestrian characteristics. The survey and questionnaire methods are utilized to gather data. In summary, the course of the study is as shown in Figure 1

Fig 1. Flow Chart

2.2 Research Location

The research was conducted in Kota Pontianak on Jl. A. Yani, Pontianak Selatan District.

Fig 2. Research Location

2.3 Data

In this study, there are 2 data used, namely primary data and secondary data. Preliminary data is in the form of data on the volume of pedestrians passing, data on the travel time of pedestrians passing, and questionnaire data or questionnaires from pedestrians. At the same time, secondary data is in the form of study location maps and road data in the South Pontianak District.

Primary data were obtained from field surveys conducted on Saturday, Sunday, and Monday for 7 hours from 06.00 - 09.00 and 16.00 - 20.00 WIB. In the field survey, observations were made of the characteristics of various movements, including volume and duration.

2.4 Analysis Method

The Likert Scale method was employed to analyze survey data and determine the level of pedestrian comfort and safety as perceived by the respondents.

2.4.1. Pedestrian Path Dimensions

The sidewalk width needs are calculated based on pedestrian volume (V). Pedestrian volume is the average volume per minute at peak intervals; V is calculated based on pedestrian counting surveys conducted every 15-minute intervals for the 12 busiest hours in one day for two directions..

$$W = \frac{V}{35} + N \quad (1)$$

Where:

W : Width sidewalk (m)
V : Volume pedestrian foot/ 2 direction (people/m/min)
N : Width extra according to the rules (m)

Table 1. Determination Wide Sidewalk Additional (Director General Building Many, 1990)

N (m)	Condition
1,5	High pedestrian awakening*
1	Moderate pedestrian awakening**
0,5	Low pedestrian rise***

2.4.2. Pedestrian Characteristics

1. Pedestrian flow can be calculated using the following formula:

$$Q = \frac{N}{T} \quad (2)$$

Where:

Q : Volume pedestrian feet (org/m/sec)
N : Amount pedestrian feet (people/m)
T : Observation time (minutes)

2. Pedestrian speed can be calculated using the following formula:

$$V = \frac{L}{t} \quad (3)$$

Where:

V : pedestrian speed (m/sec)
L : Length of observation point (m)
t : Pedestrian travel time (second)

Meanwhile, the average speed of space (Vs) is obtained by the formula:

$$Vs = \frac{1}{\frac{1}{n}\sum_{i=1}^{n}\frac{1}{Vi}} \quad (4)$$

Where:

Vs : The average speed of space (m/min)
n : Number of data
Vi : Pedestrian speed (m/min)

3. Pedestrian density is calculated using the formula:

$$D = \frac{Q}{Vs} \quad (5)$$

Where:

D : density (org/m^2)
Q : current (person/m/min)
Vs : average speed of space (m/minute)

4. Pedestrian space can be calculated using the following formula:

$$S = \frac{Vs}{Q} = \frac{1}{D} \quad (6)$$

Where:

S : Pedestrian space (m^2/org)
D : Density (people/m)
Q : Current (flow) (pedestrians/sec/m)
Vs Room average velocity (m/min)

5. Pedestrian ratio the ratio between current and pedestrian capacity is obtained by the ratio of the following formula:

$$r = \frac{in}{c} \quad (7)$$

Where:

r : Pedestrian capacity current ratio
in : pedestrian flow (pedestrians feet/minute/meter)
c : Pedestrian capacity (75 pedestrians feet/minute/meter)

2.4.3. Relations Between Variables

1. Speed and density relationship, to find the relationship between speed and density, you can use the following formula:

$$Vs = Vf - \left(\frac{Vf}{Dj}\right) . D \quad (8)$$

Where:

Vs : Room average velocity (m/min)
Vf : Average free flow speed (m/min)
D : Density (org/m^2)

2. The relationship between current and density, to find the relationship between speed and density, you can use the following formula:

$$Q = Vf . D - \left(\frac{Vf}{Dj}\right) . D^2 \quad (9)$$

Where:

Q : Flow (org/min)
Vf : Average free flow speed (m/min)
D : Density (org/m^2)
Dj : Density at total traffic jam condition (org/m^2)

3. The relationship between current and speed, to find the relationship between speed and density, you can use the following formula:

$$Q = Dj . Vs - \left(\frac{Dj}{Vf}\right) . Vs^2 \quad (10)$$

Q : Flow (org/min)
Vs : Room average velocity (m/min)
Vf : Average free flow speed (m/min)
D : Density (org/m^2)
Dj Density at total traffic jam condition (org/m^2)

2.4.4. Linear Regression and Correlation Coefficient

Write it in the regression equation to get the equation Y = a + bx with values a and b like the following formula:

$$a = \frac{\sum Y . \sum X^2 - \sum X . \sum XY}{n . \sum X^2 - (\sum X)^2} \quad (11)$$

$$b = \frac{n . \sum XY . \sum X^2 - \sum X . \sum Y}{n . \sum X^2 - (\sum X)^2} \quad (12)$$

Where:

a : Constant number
b : Regression coefficient
n : Amount of data
X : Independent variable (density)
Y : Dependent variable (speed)

The correlation coefficient value is obtained in the following formula:

$$r = \frac{n \cdot \sum XY - \sum X \cdot \sum Y}{\left(n \cdot \sum X^2 - (\sum X)^2\right) \cdot \left(n \cdot Y^2 - (\sum Y)^2\right)} \quad (13)$$

Where:
n : Number of data
X : Independent variable (ab scissor)
Y : dependent variable (ordinate)
r : Correlation coefficient

2.4.5. Pedestrian Service Level

To calculate the value of pedestrian flow at 15-minute intervals, the formula is:

$$Q15 = \frac{Nm}{15.WE} \quad (14)$$

Where:
Nm : The highest number of pedestrians in the interval of 15 minute
Q15 : pedestrian flow at 15-minute intervals largest (org/min/m)
WE : effective width of the pedestrian path (m)

Meanwhile, to calculate the value at the time of the largest flow of 15 minutes, the following formula will be obtained:

$$S15 = \frac{1}{D15} \quad (15)$$

Where:
S15 : Space for pedestrians at current 15 the greatest minute (m^2/org)
D15 : Density at current 15 min largest (org/m^2)

Table 2. Sidewalk Service Level **(**Director General of Highways, 1990)

Service Level	Space (m2/Org)	Volume (Org/m/mnt)
A	≥ 3,25	≤ 23
B	2,30 – 3,23	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

2.4.6. Likert scale

Find the percentage of scores obtained by using the Likert Scale formula:

$$\% = \frac{n}{N} \times 100\% \quad (16)$$

n : total score of respondents
N : Total maximum score

Table 3. Leisure Level Percentage Class Interval

Class Interval (%)	Criteria
100% > x > 84%	Very Good (SB)
84% > x > 68%	Good (B)
68% > x > 52%	Good Enough (CB)
52% > x > 36%	Not Good (TB)
36% > x > 20%	Very Not Good (STB)

3. Result and Discussion

The research was conducted on roads in Pontianak Selatan District which are considered representative, and there is pedestrian activity on these roads. By the Pavement Planning Guidelines (Dirjen Bina Marga, 1990), it is deemed necessary to equip a street with sidewalks if there are land uses along the road that has the potential to cause pedestrians. Where for the road segment is Jalan Ahmad Yani, with the research object of pedestrian paths in shopping centers, shops, trading activities for goods and services, and banking that occur, as well as the high intensity of pedestrians generated on each of these roads

3.1. Collection and Presentation of Survey Data

a. Sidewalk area A

Obtained pedestrian data for 7 hours which can be seen in the attachment with the following details:

Saturday = 2,617 people / 7 hours
Sunday = 3,579 people / 7 hours
Monday = 752 people / 7 hours

From the survey results, it was found that peak conditions occurred on Sundays, namely 3,579 people / 7 hours, so that the analysis was carried out based on the peak condition data.

b. Sidewalk Zone B

Data on the number of pedestrians for 7 hours can be seen in the attachment with the following details:

Saturday = 1,378 people / 7 hours
Sunday = 1,665 people / 7 hours
Monday = 306 people / 7 hours

From the survey results, it was found that peak conditions occurred on Saturday, namely 1,665 people / 7 hours, so that the analysis will be carried out based on the peak condition data.

c. Sidewalk zone C

Data on the number of pedestrians for 7 hours can be seen in the attachment with the following details:

Saturday = 1,800 people / 7 hours

Sunday = 1,487 people / 7 hours

Monday = 281 people / 7 hours

From the survey results, it was found that peak conditions occurred on Saturday, namely 1,800 people / 7 hours, so that the analysis will be carried out based on the peak condition data.

3.2. Pedestrian Lane Width Needs Analysis

a. Sidewalk area A

The survey results in zone A sidewalks obtained the number of pedestrians on Sunday peak conditions at 15minute intervals, namely 19.45-20.00 WIB as many as 264 people / 15 minutes. Calculation of the need for pedestrian lane width based on pedestrian data is planned as follows:

V = $\frac{264}{15}$ = 17,6 ≈ 18 org / mnt

Based on table 1, the value of N for the location of the road in the market area is 1 m, then:

W = $\frac{18}{35}$ + 1 = 1,51 m ≈ 1,5 m

Based on the Technical Planning for Pedestrian Facilities (Ministry of PUPR, 2017), the effective width of the sidewalk required for Arterial Road locations is 2.75 – 3.75 m.

b. Sidewalk area B

The survey results in zone B sidewalks obtained the number of pedestrians on Sunday peak conditions at 15 minute intervals, namely 07.30 - 07.45 WIB as many as 354 people / 15 minutes. Calculation of the need for pedestrian lane width based on pedestrian data is planned as follows:

V = $\frac{354}{15}$ = 23,5 ≈ 24 org / mnt

Based on table 1, the value of N for the location of the road in the market area is 1 m, so:

W = $\frac{26}{35}$ + 1 = 1,68 m ≈ 1,7 m

Based on the Technical Planning for Pedestrian Facilities (Ministry of PUPR, 2017), the effective width of the sidewalk required for Arterial Road locations is 2.75 – 3.75 m.

c. Sidewalk zone C

The survey results in zone C sidewalks obtained the number of pedestrians at peak conditions on Monday at 15 minute intervals, namely 07.45 - 08.00 WIB as many as 184 people / 15 minutes. Calculation of lane width requirements pedestrian based on pedestrian data is planned as follows:

V = $\frac{184}{15}$ = 12,26 ≈ 12 org / mnt

Based on table 1, the value of N for the location of the road in the market area is 1 m, so:

W = $\frac{12}{35}$ + 1 = 1,34 m ≈ 1,3 m

Based on the Technical Planning for Pedestrian Facilities (Ministry of PUPR, 2017), the effective width of the sidewalk required for Arterial Road locations is 2.75 – 3.75 m.

3.3. The Amount of Pedestrian Flow During Peak Conditions

a. Sidewalk area A

Current calculation (*flow*) Pedestrians on Zone A sidewalks during peak conditions on Sundays at 19.45 – 20.00 WIB are as follows:

- Observation time = 15 minutes
- Number of pedestrians = 264 people
- Pavement width = 6 m

Q = $\frac{N}{T}$ = $\frac{264\ org\ /\ 6\ m}{15\ mnt}$ = 2,93 org/m/mnt

1. Sidewalk area B

Current calculation (*flow*) Pedestrians on Zone B sidewalks during peak conditions on Sundays at 07.30-07.45 WIB are as follows:

- Observation time = 15 minutes
- Number of pedestrians = 354 people
- Pavement width = 4,45 m

Q = $\frac{N}{T}$ = $\frac{354\ org\ /\ 4{,}45\ m}{15\ mnt}$ = 5,3 org/m/mnt

b. Sidewalk zone C

current calculation (*flow*) Pedestrians on Zone C sidewalks in peak conditions on Saturday at 07.45-08.00 WIB are as follows:

- Observation time = 15 minutes
- Number of pedestrians = 184 people
- Pavement width = 9 m

Q = $\frac{N}{T}$ = $\frac{184\ org\ /\ 9\ m}{15\ mnt}$ = 1,36 org/m/mnt

3.4. The Amount of Pedestrian Flow During Peak Conditions

a. Sidewalk area A

Calculation of pedestrian speed on Zone C sidewalks during peak conditions on Saturday at 19.45-20.00 WIB as follows:

Table 4. Average Speed of Pedestrians at Peak Conditions (Data Analysis, 2022)

Travel Time Table	Number of Samples	Travel Time (seconds)	Speed
19.45-20.00	1	4,7	63,83
	2	4,88	61,48
	3	7	42,86
	4	5,9	50,85
	5	6,8	44,12
	Σ	29,28	263,13
Average		5,86	51,23

Finding the speed value can use the following formula:

$V = \frac{L}{T} = \frac{5}{4,7 / 60}$ = 63.83 m/mnt

Space average speed:

$Vs = \frac{1}{\frac{1}{n}\sum_{i=1}^{n} \frac{1}{V}}$

$Vs = \frac{1}{\frac{1}{5} x \left(\frac{1}{63,83}\right) + \left(\frac{1}{61,48}\right) + \left(\frac{1}{42,86}\right) + \left(\frac{1}{50,85}\right) + \left(\frac{1}{44,12}\right)}$

= 51,23 m/mnt

b. Sidewalk area B

Calculation of pedestrian speed on sidewalk zone B during peak conditions on Saturday at 07.30-07.45WIB as follows:

Table 5. Average Speed of Pedestrians at Peak Conditions (Data Analysis, 2022)

Travel Time Table	Number of Samples	Travel Time (seconds)	Speed
07.30-07.45	1	6,91	43,42
	2	7,81	38,41
	3	7,37	40,71
	4	6,89	43,54
	5	7,51	39,95
	Σ	36,49	206,02
Average		13,084	41,20

Finding the speed value can use the following formula:

$V = \frac{L}{T} = \frac{5}{6,91 / 60}$ = 43,42 m/mnt

Space average speed:

$Vs = \frac{1}{\frac{1}{n}\sum_{i=1}^{n} \frac{1}{IN}}$

$Vs = \frac{1}{\frac{1}{5} x \left(\frac{1}{43,42}\right) + \left(\frac{1}{38,41}\right) + \left(\frac{1}{40,71}\right) + \left(\frac{1}{43,54}\right) + \left(\frac{1}{39,95}\right)}$

= 41,20 m/mnt

c. Sidewalk area C

Calculation of pedestrian speed on Zone C sidewalks during peak conditions on Saturday at 07.45-08.00WIB as follows:

Table 6. Average Speed of Pedestrians at Peak Conditions

Travel Time Table	Number of Samples	Travel Time (seconds)	Speed
07.45-08.00	1	7,68	47
	2	8,69	48,82
	3	9,15	45,01
	4	9,31	48,47
	5	8,63	51,02
	Σ	43,46	243,57
Average		8,69	48,62

Finding the speed value can use the following formula:

$V = \frac{L}{T} = \frac{10}{11,94 / 60}$ = 50,25 m/mnt

Space average speed:

$Vs = \frac{1}{\frac{1}{n}\sum_{i=1}^{n} \frac{1}{IN}}$

$Vs = \frac{1}{\frac{1}{5} x \left(\frac{1}{50,25}\right) + \left(\frac{1}{48,82}\right) + \left(\frac{1}{45,01}\right) + \left(\frac{1}{48,47}\right) + \left(\frac{1}{51,02}\right)}$

= 48,62 m/mnt

3.5. Pedestrian Density Level During Peak Conditions

a. Sidewalk area A

Calculation of pedestrian density on sidewalks in zone A during peak conditions on Sundays at 08.15 – 08.30 WIB, as follows:

Is known : Q = 2,63 org/m/mnt

Vs = 48,62 m/mnt

Density :

D = $\frac{Q}{Vs}$ = $\frac{2,63}{48,62}$ = 0,055 org/m^2

1. Sidewalk area B

Calculation of pedestrian density in zone B sidewalks during peak conditions on Saturday at 08.15 – 08.30 WIB, as follows:

Is known : Q = 10,37 org/m/mnt

Vs = 45,87 m/mnt

Density :

D = $\frac{Q}{Vs}$ = $\frac{10,37}{45,87}$ = 0,257 org/m^2

b. Sidewalk zone C

Calculation of pedestrian density on sidewalk zone C during peak conditions on Saturday at 08.15 – 08.30 WIB, as follows:

Is known : Q = 1,93 org/m/mnt

Vs = 48,62 m/mnt

Density :

D = $\frac{Q}{Vs}$ = $\frac{1,93}{48,62}$ = 0,040 org/m^2

3.6. Pedestrian Space During Peak Conditions

a. Sidewalk area A

Space calculation (*space*) pedestrians in Zone A sidewalks at peak conditions Sundays 08.15 – 08.30 WIB, as follows:

Is known : Q = 2,63 org/m/mnt

Vs = 48,31 m/mnt

D = 0,055 org/m^2

Space calculation (*space*) :

S = $\frac{1}{D}$ = $\frac{1}{0,055}$ = 18,35 m^2/org

S = $\frac{Vs}{Q}$ = $\frac{48,31}{2,63}$ = 18,35 m^2/org

b. Sidewalk area B

Space calculation (*space*) pedestrians in Zone B sidewalks at peak conditions Saturday at 08.15 – 08.30 WIB, as follows:

Is known : Q = 11,79 org/m/mnt

Vs = 45,87 m/mnt

D = 0,257 org/m^2

Space calculation (*space*) :

S = $\frac{1}{D}$ = $\frac{1}{0,257}$ = 3,89 m^2/org

S = $\frac{Vs}{Q}$ = $\frac{45,87}{11,79}$ = 3,89 m^2/org

c. Sidewalk zone C

space calculation (*space*) pedestrians in Zone C sidewalks at peak conditions Monday at 08.15 – 08.30 WIB, as follows:

Is known : Q = 1,93 org/m/mnt

Vs = 48,62 m/mnt

D = 0,040 org/m^2

Space calculation (*space*) :

S = $\frac{1}{D}$ = $\frac{1}{0,040}$ = 25,15 m^2/org

S = $\frac{Vs}{Q}$ = $\frac{48,62}{1,93}$ = 25,15 m^2/org

3.7. Pedestrian Ratio During Peak Conditions

a. Sidewalk area A

Pedestrian flow (Q) = 2,633 org/m/mnt

Assumed Capacity (C) = 75 org/m/mnt

Ratio calculation:

R = $\frac{Q}{C}$ = $\frac{2,63}{75}$ = 0,035 org/m/mnt

1. Sidewalk area B

Pedestrian flow (Q) = 11,788 org/m/mnt

Assumed Capacity (C) = 75 org/m/mnt

Ratio calculation:

R = $\frac{Q}{C}$ = $\frac{11,788}{75}$ = 0,157 org/m/mnt

b. Sidewalk zone C

Pedestrian flow (Q) = 1,933 org/m/mnt

Assumed Capacity (C) = 75 org/m/mnt

Ratio calculation:

R = $\frac{Q}{C}$ = $\frac{1,933}{75}$ = 0,026 org/m/mnt

3.8. Relations Between Variables

a. The relationship between density (D) and speed (Vs)

The following is an example of calculating the linear regression relationship between density and pedestrian speed on Zone A sidewalks during peak conditions on Saturday, 19.45 – 20.00 WIB.

- Calculating variable a :

$$a = \frac{\sum Y^* \sum X^2 - \sum X^* \sum XY}{n^* \sum X^2 - (\sum X)^2}$$

$$a = \frac{1403,513 \times 0,0295 - 0,798 \times 39,767}{28 \times 0,0295 - (0,798)^2}$$

$$= 51,096$$

- Menghitung variabel b :

$$b = \frac{n^* \sum XY - \sum X^* \sum Y}{n^* \sum X^2 - (\sum X)^2}$$

$$b = \frac{28 \text{ x } 39{,}767 - 0{,}798 \text{ x } 1403{,}513}{28 \text{ x } 0{,}0295 - (0{,}798)^2}$$

$$= -34{,}081$$

Then the linear equation obtained as follows:

Y = 51.096 – 34.081 X or in terms of speed and density it is written as Vs = 51.096 – 34.081 D.

To obtain the correlation coefficient that occurs in this linear regression is calculated using the formula:

- Calculating the correlation coefficient (r):

$$r = r = \frac{n^* \sum XY - \sum X^* \sum Y}{\sqrt{(n^* \sum X^2 - (\sum X)^2) \text{ x } (n^* \sum Y^2 - (\sum Y)^2)}}$$

$$= \frac{28 \text{ x } 39{,}767 - 0{,}798 \text{ x } 1403{,}513}{\sqrt{(28 \text{ x } 0{,}0295 - (0{,}798)^2) \text{ x } (28 \text{ x } 73057{,}917 - (733057{,}917)^2)}}$$

$$= -0{,}0554$$

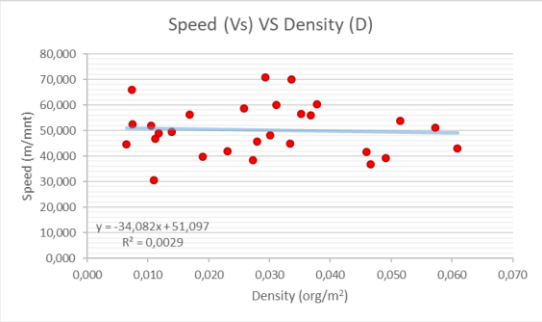

Figure 3. The relationship between density and sidewalk speed in zone A

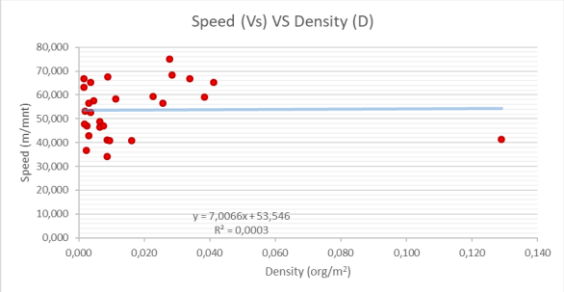

Figure 4. The relationship between density and sidewalk speed in zone B

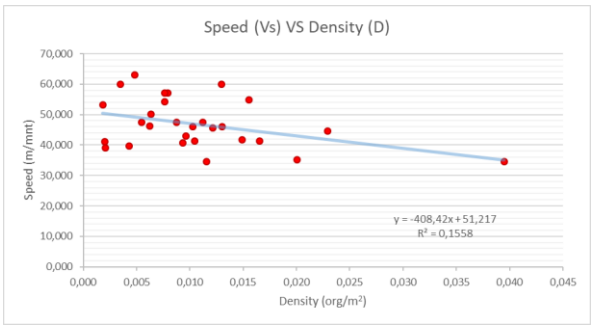

Figure 5. The relationship between density and sidewalk speed in zone C

b. Relationship Between Density (D) and Flow (Q)

An example of the calculation of the relationship between density and current on the sidewalks of zone B using linear regression on sidewalks of zone A is the equation Vs = 51.096 – 34.081 D, to get the constant value of Vf and Dj, then the equation can be used as a linear equation $y = a + bx$ with a = Vf, $b = \frac{Vf}{Dj}$, x = D, and y = Vs, so from these equations it is known: a = Vf = 51.096 and b = $\frac{Vf}{Dj}$ = 34,081.

Then it is known that the relationship between density and current forms a parabolic equation as follows:

$Q = 51.096D – 34.081D^2$

Graph of the relationship between density and pedestrian flow at peak conditions:

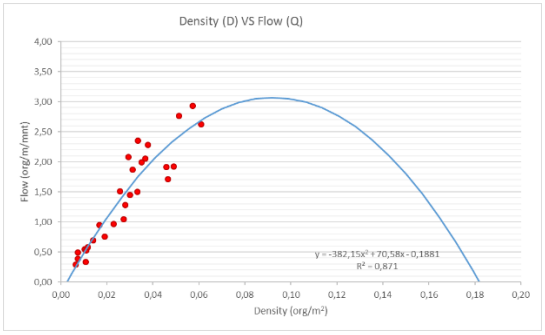

Figure 6. The relationship between density and sidewalk currents in zone A

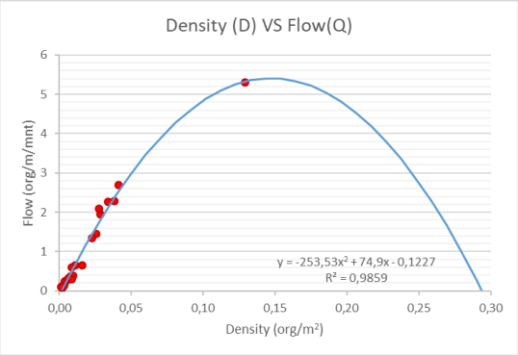

Figure 7. The relationship between density and sidewalk currents in zone B

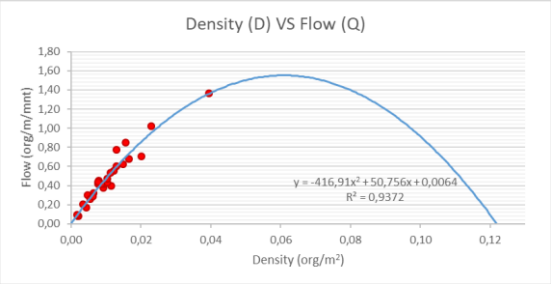

Figure 8. The relationship between density and sidewalk currents in zone C

c. Relationship between Speed (Speed) with Current (Flow)

An example of the calculation results on the relationship between density and speed in Zone A sidewalks, it is known that: Vf = 51.096 and $\frac{Vf}{Dj}$ = 34,081

By substituting Vf, we get: $\frac{51,096}{Dj}$ = 34,081

Until obtained Dj = 1,499

To find out the relationship between density and free flow (Vf) is known, then:

$\frac{Dj}{Vf} = \frac{1,499}{51,096}$ = 0,0029

In order to obtain a parabolic equation for the relationship between velocity and current as follows:

Q = 1,499 Vs – 0,0029 Vs^2

From this equation, a graph of the relationship between speed and flow is made, where the flow data is the X variable and the speed is the Y variable. The graph can be seen in the image below:

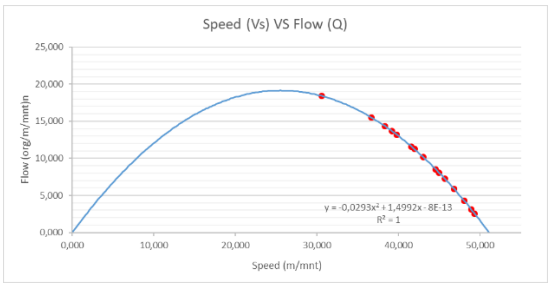

Figure 9. Graph of the Relationship between Speed and Flow of Zone A Sidewalks

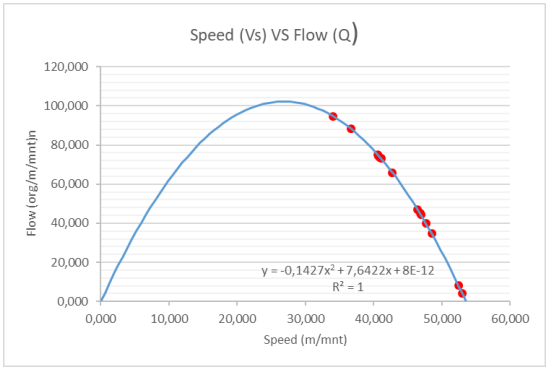

Figure 10. Graph of the Relationship between Speed and B Zone Pavements

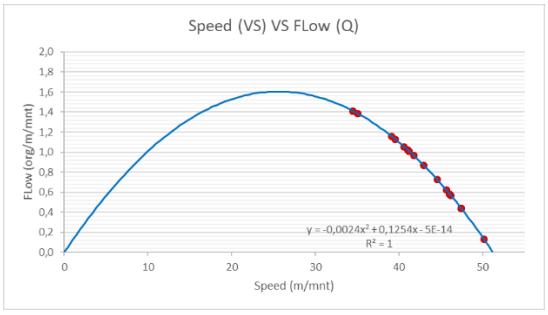

Figure 11. Graph of the Relationship between Speed and C Zone Pavements

3.9. Analysis of Planning Level of service for Pedestrian Pathways *ILevel Of Service* (LOS)

In determining the level of pedestrian service in zone A sidewalks, zone B sidewalks, and zone C sidewalks, two methods are used as a comparison, namely pedestrian flow for 15 minutes and pedestrian space for 15 minutes, as follows:

Table 6. Table of Planned Service Levels

No.	Location Name	Flow (org/m/mnt)	Space (m^2/org)	LOS
1	Sidewalk area A	2,93	17,45	A
2	Sidewalk area B	5,30	7,75	A
3	Sidewalk zone C	1,36	25,33	A

3.10. Pedestrian Questionnaire Data Analysis

The following results of the calculation of the percentage of comfort level categories based on class intervals of the comfort level percentage listed in the table, can be seen in the table below:

Table 7. Calculation of the Percentage of the Pedestrian Comfort Level Category

No.	Statement	Score	Percentage (%)	Category
1	Hot microclimate	788	69%	B
2	Rain microclimate	684	59%	CB
3	Road layout	818	71%	B
4	Sidewalk layout	834	73%	B
5	Vehicle noise	773	67%	CB
6	Bad smell/smell	838	73%	B
7	The shape and quality of the road shoulders	887	77%	B
8	Security from crime	803	70%	B
9	Safety of other road users	848	74%	B
10	Hygiene conditions	950	83%	B
11	Accessibility	858	75%	B
12	Beauty	874	76%	B
13	Road facilities	863	75%	B

4. Conclusion

Based on the results of the analysis, the characteristics of pedestrians passing through the observation location and also the relationship between pedestrian movement variables on Zone A sidewalks, Zone B sidewalks, and Zone C sidewalks are obtained by referring to the Pavement Planning Guidelines (Dirjen Bina Marga, 1990) it can be seen that the level of service of pedestrian paths on zone A sidewalks, zone B sidewalks, and zone C sidewalks in South Pontianak District, is level of service A (LOS A). According to respondents, three factors cause discomfort for pedestrians using sidewalks: hot microclimate, rain microclimate, and vehicle noise. From the research, it is deemed necessary to add or build sidewalks that do not yet have shade facilities in the South Pontianak District area, especially at the location used as the study location, to provide a sense of comfort and safety for pedestrians crossing the road. In addition, to increase the level of comfort for pedestrians on Jl. Ayani, arranging a pedestrian path that is adjusted to the existing requirements and regulations is necessary. This research can be continued with similar research using more detailed data, extended observations, and equipment such as video and other methods. In addition, it is necessary to examine pedestrian facilities on Jl. A. Yani and other roads in Pontianak City on the other side so that the level of pedestrian comfort in Pontianak City increases.

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6. Author's Note

The author now declares that this article is an original work and does not plagiarize any research, as it has successfully passed the examination to obtain a bachelor's degree in engineering at the Faculty of Engineering, Tanjungpura University.

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