Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 45 No. 1 (2024)

Characteristics of Pedestrian Movement on the Pedestrian Path Around the Makassar City Flying Road

Astrid Ayodya Anindita[1], Ihsan*[2], M. Ramli[3]

[1]*Master of Urban Management, Hasanuddin University Graduate School, Makassar, Indonesia*

[2]*Department of Regional and City Development Engineering, Faculty of Engineering, Hasanuddin University, Makassar, Indonesia*

[3]*Department of Social and Political Sciences, Hasanuddin University Makassar, Indonesia*

***Abstract*:-** This research aims to determine the characteristics of pedestrian movement on pedestrian paths around the Makassar City flyover. The method used in this research is quantitative. The results of this research are the characteristics or movements of pedestrians walking on the pedestrian road around the Jl. Urip Sumoharjo Makassar is relatively small, because data on pedestrian flow and density on average only reaches 3-4 pedestrians/minute/m. The analysis carried out is in the form of relationships between variables that have been obtained through calculations using the greenshield method on pedestrian roads on the Urip Sumohardjo Makasar elevated toll road section, showing the relationship between flow variables, in the form of density and speed.

Keywords: *Pedestrians, Flyovers, Makasar City*

1. Introduction

Pedestrian roads are one of the important elements in urban areas that support population mobility and cannot be separated from road users, especially pedestrians [1]. The pedestrian path is intended as a special space for pedestrians which functions as a means of achieving the goal to be achieved, namely being able to protect pedestrians from dangers originating from motorized vehicles [2]. Pedestrian paths must meet physical criteria in terms of pedestrian facilities and infrastructure. The physical condition of the pedestrian path also greatly determines the quality of the pedestrian path itself [1].

If a pedestrian is weak in that position, if he mixes with other vehicles, there will be a slowdown in traffic flow. Therefore, the need for traffic management is to try to provide distance for pedestrians from motorized vehicles, without major disruption to accessibility by building road sidewalks. The need for sidewalks can be identified from the volume of pedestrians walking on the road, the level of accidents between vehicles and pedestrians and complaints or requests from the public [3].

Makassar City is known as one of the most advanced cities in South Sulawesi Province as well as a center for education, tourism, business, trade and banking. With the title as an educational city and business and trade center,The goal of many people coming to Makasar City is that many people want to continue their studies to a higher level and carry out business activities that open up more promising business opportunities [4].

One of the problems of Makassar City in the transportation sector is the increase in transportation modes and mobility which is not balanced with the availability of transportation infrastructure, so the Provincial Government of South Sulawesi and the city of Makassar are building roads and flyovers at several points in the CBD (Central Business District) to overcome the problem of traffic jams.There is. In Makassar City, this has not yet touched on the pedestrian infrastructure around the flyover construction [5].

Data released by the Makasar Samsat in 2019 recorded 1,425,151 vehicles or has increased to 87,009 compared to last year 2018. In 2017, the number of motorized vehicles in the Daeng Baru City area was around 1,252,755 units. . This means that in the last 2 years there has been a record addition of around 172,395 units. If

given the average growth of motorized vehicles in Makasar is around seven percent (7%) every year. This growth rate has been dominated by motor vehicles since 2017 until it has grown to one million motorbike units.

In 2019, there were 1,128,809 motorized vehicles in Makasar. The number of motorized vehicles is significantly different compared to cars or similar vehicles. Details of the data include 206,435 passenger cars, 17,264 units of buses, 72,239 units of goods cars and 403 units of special vehicles. This is because the increase in existing motorized vehicles is not commensurate with the pedestrian growth rate of only 1.28% per year. Current conditions of road growth on Jalan Urip Sumoharjo in 2021, which is a primary arterial road with a road width of 8 meters.

The number of residents currently in Makasar provides data figures that always increase every year because of the magnet that makes people come. This attraction can be due to trade, business, education and tourism activities in Makasar, the city of Makasar is a very developing city. rapidly from year to year so that there is a very close relationship between the city and the need for transportation that is suitable for land use[5]. The number of people in Makasar City is dominated by students with a large number dominated by workers and students from outside Makasar City and they definitely need a place to stay that is close to their workplace or campus sector. The main reason is the ease of accessibility or efficiency of time distance in traveling from their place of residence to the campus or center where they work, so walking is one of the most common options for students or workers to save money.[6].

The area around Jalan Urip Sumoharjo is dominated by land cover or residential land use that is not commensurate with public green open space. Jalan Urip Sumoharjo is a road that has complex residential, educational, government and health land use where the road width is > 8 m. Unfortunately, the pedestrian infrastructure on the road that connects the campus area and the business/commerce center, namely along Jalan Urip Sumoharjo and the center of trade or business activities, currently has several problems which affect the level of service of the pedestrian path itself.

Some of the problems in handling pedestrian crossings on Jalan Urip Sumoharjo in Makasar City currently include the small dimensions or sidewalks that can only be passed by one or two pedestrians walking side by side or when they meet other people on the street from different directions, so this provides little space for pedestrians. The condition of the pedestrian path on Jalan Urip Sumoharjo is approximately two meters (2) metersSome of the gaps or crucial points that connect one area to another area are heavily damaged or unfit to pass through and several points cannot be found in them [6].

People or students who use walking as transportation on the path to work or campus prefer to walk on the road because the width of the sidewalk provided is very small, it is possible for pedestrians to walk side by side or pass other pedestrians from different directions so as not to touch each other. or cause problems[6]. Of course, everything has the potential to be dangerous for the safety of pedestrians considering that the traffic situation on Jalan Urip Sumoharjo is very congested and many motorbikes or cars don't care about pedestrians or when crossing the road. This is the background to this research. In this research, the problem formulation used is (1) what are the characteristics of pedestrians on the pedestrian path on the Urip Sumoharjo road around the Makassar flyover in terms of the values of flow, speed, density and space for pedestrians (2) what is the relationship between variables from the values flow, speed and density of the characteristics of pedestrian movement on the pedestrian path on the Urip Sumoharjo road section around the Makasar flyover using the greenshield method (3) What dimensions of sidewalk width are needed on the pedestrian path on the Urip Sumoharjo road section around the Makassar flyover (4) what is the level of service on the pedestrian path on the Urip Sumoharjo road around the Makassar flyover.

2. Research methods

This research uses a descriptive method with a quantitative approach. The research location is Jalan Urip Sumoharjo which has complex land uses such as education, commercial, health facilities and offices. The choice of research location was based on an interesting phenomenon where on Jalan Urip Sumoharjo, which is a provincial road and is a primary arterial road which became the point of construction of the first flyover in West Sulawesi Province, all transportation systems, both private and public transportation, pass through this road to get to Makassar city center. There is complexity in land use and activities that influence the use and mobilization of pedestrian paths. The research locations were selected in several places where the conditions were considered to represent a picture of existing problems, related to the evaluation of pedestrian infrastructure due to the construction of flyovers where the pedestrian paradigm is actually the top of the pyramid of sustainable urban transportation.

The research location is specifically on the pedestrian path along Jalan Urip Sumohardjo. Researchers divide it into two observation points that represent each function of the flyover service area, namely:

a. Point 1 on Jl. Urip Sumoharjo in front of Awal Bros Hospital/ Primayana Hospital Makassar and the Provincial Plantation Service. South Sulawesi which represents the area of health facilities and office centers
b. Point 2 on Jl. Urip Sumoharjo in front of UMI and Bosowa University Makassar which represents the educational center area

3. Results and Discussion

Condition of Urip Sumohardjo Road

Jl. Urip Sumohardjo is an area that is the center of provincial government, economy and education. Buses and city transportation heading to the city center will certainly pass through this road. Activities in this road area are very busy and varied from police, civil servants, private employees, students and the general public. Jl. Urip Sumohardjo is a protocol road that often causes traffic jams at certain times. The points that are the research centers are:

a) Point 1 : Jl. Urip Sumohardjo (Front of the Plantation Service)

b) Point 2: Jl. Urip Sumohardjo (Front of Primaya Hospital)

c) Point 3: Jl. Urip Sumohardjo (Front of Bosowa University)

d) Point 4: Jl. Urip Sumohardjo (Front of Indonesian Muslim University)

Pedestrian Path Conditions

Based on documentation, direct surveys and measurements at the research location regarding current conditions, it is known that along the pedestrian route there is open drainage in addition to the route which is limited by placing concrete benches along the route. Lighting on the pedestrian path Jl. Urip Sumoharjo is sufficient for carrying out activities at night. Signs, for example, zebra crossings are available at almost every intersection with other roads. Signs in the form of traffic symbols are placed on the edge of the pedestrian path.

The crowd on the pedestrian route occurs almost along the pedestrian route Jl. Urip sumohardjo and peak hour crowd times occur at certain times, namely in the morning 08.45 – 10.45 WITA, in the afternoon 11.45 – 12.45 WITA, in the afternoon 16.30 – 17.30 WITA, and in the evening 19.00 – 20.00 WITA. The research was conducted Monday-Wednesday/22-24 November 2021.

The function of the pedestrian path on Jl. Urip Sumohardjo is very diverse. Apart from the special function of the path as a pedestrian path, there are other user activities in it. Many other activities use this pedestrian path, including: as a space to wait for vehicles, socializing, selling hawkers, sitting and resting. Paving pedestrian paths using concrete pavement can increase pedestrian comfort on pedestrian paths. The condition of the pedestrian path is flat and almost along this route there are no stairs going up or down which disturb the activities of pedestrian path users. The facilities available on this route are zebra crossings and bus stops, although facilities such as rubbish bins and other special facilities are not yet available along the pedestrian route which is the research site.

Pedestrian Path Support Facilities

There are only 2 (two) supporting facilities that support the function of the pedestrian path on Jalan Urip Sumoharjo, namely: the Zebra Cross Path which is in good condition and is still used by pedestrians and several bus stopping points (Bus Stops) which are still used by some pedestrians to wait. bus/pete-pete mode of transportation but the conditions are uncomfortable because the condition of the building is starting to crumble (the ceiling is missing at several points and is leaking and the seating is minimal and dirty),

Relationship Between Pedestrian Movement Characteristic Variables Using the Greenshield Method

With the Greenshield model approach, the characteristics of pedestrian movement variables above are modeled mathematically to determine the relationship between these variables. This Greenshield model is the earliest attempt to observe traffic behavior. This Greenshield model is used because it is a model that is simple and easy to use. Greenshield obtained the results that the relationship between speed and density is linear and the relationship between current and speed and current and density is parabolic.

Relationship between Speed and Density

The relationship between speed and density is calculated using the linear regression method according to the method used by Greenshield, namely by describing density data as the independent variable (X) and space average speed data as the dependent variable (Y).

Point 1 : Jl. Urip Sumohardjo (Front of the Plantation Service)

Table 1. Table of Linear Regression Calculation Results

Time (Monday-Wednesday)	D=	Vs= Y	X2	Y2	X*Y
08.45-08.50	0.0018	300	0.00000324	90000	0.54
08.50-08.55	0.0048	111.11	0.00002304	12345.43	0.53
08.55-09.00	0.0018	200	0.00000324	40000	0.36
09.00-09.05	0.0032	111.11	0.00001024	12345.43	0.35
09.05-09.10	0.0034	157.89	0.00001156	24929.25	0.53
09.10-09.15	0.0046	115.38	0.00002116	13312.54	0.53
09.15-09.20	0	0	0	0	0
09.20-09.25	0.0016	111.11	0.00000256	12345.43	0.17
09.25-09.30	0	0	0	0	0
09.30-09.35	0.0032	111.11	0.00001024	12345.43	0.35
09.35-09.40	0.0034	105.26	0.00001156	11079.67	0.35
09.40-09.45	0.0048	148.14	0.00002304	21945.46	0.71
09.45-09.50	0.0016	111.11	0.00000256	12345.43	0.17
09.50-09.55	0	0	0	0	0
09.55-10.00	0.0034	105.26	0.00001156	11079.67	0.35
10.00-10.05	0.0016	111.11	0.00000256	12345.43	0.17
10.05-10.10	0.0036	150	0.00001296	22500	0.54
10.10-10.15	0.0143	88.60	0.00020449	7849.96	1.26
10.15-10.20	0.0067	162.16	0.00004489	26295.87	1.08
10.20-10.25	0.0032	111.11	0.00001024	12345.43	0.35
10.25-10.30	0.0036	100	0.00001296	10000	0.36
10.30-10.35	0.0039	181.81	0.00001521	33054.88	0.70
10.35-10.40	0.0050	107.14	0.000025	11478.98	0.53
10.40-10.45	0.0076	142.85	0.00005776	20406.12	1.08
11.45-11.50	0.0068	236.84	0.00004624	56093.19	1.61
11.50-11.55	0.0065	194.44	0.00004225	37806.91	1.26
11.55-12.00	0.0050	178.57	0.000025	31887.24	0.89
12.00-12.05	0.0034	105.26	0.00001156	11079.67	0.35
12.05-12.10	0.0052	275.86	0.00002704	76098.74	1.43
12.10-12.15	0.0043	125	0.00001849	15625	0.53

Time (Monday-Wednesday)	D=	Vs= Y	X2	Y2	X*Y
12.15-12.20	0.0032	333.33	0.00001024	111108.9	1.06
12.20-12.25	0.0030	176.47	0.000009	31141.66	0.52
12.25-12.30	0.0045	360	0.00002025	129600	1.62
Time (Monday-Wednesday)	**D=**	**Vs= Y**	**X2**	**Y2**	**X*Y**
12.30-12.35	0.0067	162.16	0.00004489	26295.87	1.08
12.35-12.40	0.0059	272.72	0.00003481	74376.2	1.60
12.40-12.45	0.0068	236.84	0.00004624	56093.19	1.61
16.30-16.35	0.0058	187.5	0.00003364	35156.25	1.08
16.35-16.40	0.0045	200	0.00002025	40000	0.9
16.40-16.45	0.0228	39.37	0.00051984	1549,997	0.89
16.45-16.50	0.0028	250	0.00000784	62500	0.7
16.50-16.55	0.0039	181.81	0.00001521	33054.88	0.70
16.55-17.00	0.0045	160	0.00002025	25600	0.72
17.00-17.05	0.0063	200	0.00003969	40000	1.26
17.05-17.10	0.0029	437.5	0.00000841	191406.3	1.26
17.10-17.15	0.0045	240	0.00002025	57600	1.08
17.15-17.20	0.0046	115.38	0.00002116	13312.54	0.53
17.20-17.25	0.0046	115.38	0.00002116	13312.54	0.53
17.25-17.30	0.0046	192.30	0.00002116	36979.29	0.88
19.00-19.05	0.0028	250	0.00000784	62500	0.7
19.05-19.10	0.0014	125	0.00000196	15625	0.17
19.10-19.15	0.0016	111.11	0.00000256	12345.43	0.17
19.15-19.20	0.0046	153.84	0.00002116	23666.75	0.70
19.20-19.25	0.0045	160	0.00002025	25600	0.72
19.25-19.30	0.0034	157.89	0.00001156	24929.25	0.53
19.30-19.35	0.0016	333.33	0.00000256	111108.9	0.53
19.35-19.40	0.0045	200	0.00002025	40000	0.9
19.40-19.45	0.0014	125	0.00000196	15625	0.17
19.45-19.50	0.0014	250	0.00000196	62500	0.35
19.50-19.55	0.0045	120	0.00002025	14400	0.54
19.55- 20.00	0.0045	160	0.00002025	25600	0.72
Amount	0.2564	9965.16	0.0017375	2071929	41.53

The relationship between these variables forms a linear equation where a and b can be calculated using linear regression. To calculate variables a and b, data from Table 1 is used. The linear regression calculation is as follows:

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

= (9965.16*0.0017375) – (9965.16*41.53)
(60*0.0017375) – (0.2564)2
= -10.297

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

= (60x41.53) – (0.2564 x 9965.16)
(60 x 0.0017375) – (0.2564)2
= -1642.91

So the linear equation obtained is as follows:
Y = -1642.91 – 10.297
Vs = -1642.91 – 10.297 D
To obtain the correlation coefficient that occurs in linear regression, it is calculated using the following formula, so that the correlation value obtained is:

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

=(60 x 41.53) – (0.2564 x 9965.16)
√{(60 x 0.0017375) – (0.2564)2} x {(60 x 2071929)-(9965.16)2}
= -0.0644

From the calculations we get the value r = -0.0644, a negative correlation between density and speed which means that when the density value increases, the speed increases.reduce because of pedestrian space and vice versa.

Point 2: Jl. Urip Sumohardjo (Front of Primaya Hospital)

Table 2. Table of Linear Regression Calculation Results

Time (Monday-Wednesday)	D=	Vs= Y	X2	Y2	X*Y
08.45-08.50	0.0155	74.46	0.00024	5544.29	1.15
08.50-08.55	0.0120	41.66	0.000144	1735.55	0.49
08.55-09.00	0.0107	76.92	0.000114	5916.68	0.82
09.00-09.05	0.0072	45.45	0.000051	2065.70	0.32
09.05-09.10	0.008	62.5	0.000064	3906.25	0.5
09.10-09.15	0.0068	73.17	0.000046	5353.84	0.49
09.15-09.20	0.0108	46.15	0.000116	2129.82	0.49
09.20-09.25	0.0034	50	0.000011	2500	0.17
09.25-09.30	0.0071	116.27	0.000050	13518.71	0.82
09.30-09.35	0.0070	46.51	0.000049	2163.18	0.32
09.35-09.40	0.0070	46.51	0.000049	2163.18	0.32
09.40-09.45	0.0112	58.82	0.000125	3459.79	0.65
09.45-09.50	0.0035	47.61	0.000012	2266.71	0.16
09.50-09.55	0.0035	47.61	0.000012	2266.71	0.16
09.55-10.00	0.0041	80	0.000016	6400	0.32
10.00-10.05	0.0039	43.47	0.000015	1889.64	0.16

10.05-10.10	0.0110	45.45	0.000121	2065.70	0.49
10.10-10.15	0.0147	78.65	0.000216	6185.82	1.15
10.15-10.20	0.0111	89.55	0.000123	8019.20	0.99
10.20-10.25	0.0036	90.90	0.000012	8262.81	0.32
Time (Monday-Wednesday)	**D=**	**Vs= Y**	**X2**	**Y2**	**X*Y**
10.25-10.30	0.0067	48.78	0.000044	2379.48	0.32
10.30-10.35	0.0165	40	0.000272	1600	0.66
10.35-10.40	0.0113	44.11	0.000127	1945.69	0.49
10.40-10.45	0.0151	65.93	0.000228	4346.76	0.99
11.45-11.50	0.0157	105.26	0.000246	11079.67	1.62
11.50-11.55	0.0143	127,907	0.000204	16360.2	1.82
11.55-12.00	0.0142	58.13	0.000201	3379.09	0.82
12.00-12.05	0.0151	131.86	0.000228	17387.06	1.99
12.05-12.10	0.0146	44.94	0.000213	2019,60	0.65
12.10-12.15	0.0135	85.36	0.000182	7286.33	1.15
12.15-12.20	0.0142	116.27	0.000201	13518.71	1.65
12.20-12.25	0.0141	58.82	0.000198	3459.79	0.82
12.25-12.30	0.0147	112.35	0.000216	12622.52	1.65
12.30-12.35	0.0146	68.18	0.000213	4648.51	0.99
12.35-12.40	0.0070	93.02	0.000049	8652.72	0.65
12.40-12.45	0.0111	134.32	0.000123	18041.86	1.49
16.30-16.35	0.0133	137.5	0.000176	18906.25	1.82
16.35-16.40	0.0141	94.11	0.000198	8856.69	1.32
16.40-16.45	0.0102	80.64	0.000104	6502.81	0.82
16.45-16.50	0.0136	146.34	0.000184	21415.4	1.99
16.50-16.55	0.0098	50.84	0.000096	2584.70	0.49
16.55-17.00	0.0107	107.69	0.000114	11597.14	1.15
17.00-17.05	0.0146	102.27	0.000213	10459.15	1.49
17.05-17.10	0.0064	128.20	0.000409	16435.24	0.82
17.10-17.15	0.0136	121.95	0.000184	14871.8	1.65
17.15-17.20	0.0101	98.36	0.000102	9674.69	0.99
17.20-17.25	0.0145	45.97	0.000210	2113.24	0.66
17.25-17.30	0.0106	140.62	0.000112	19773.98	1.49
19.00-19.05	0.0101	49.18	0.000102	2418.67	0.49
19.05-19.10	0.0068	73.17	0.000046	5353.84	0.49
19.10-19.15	0.0072	90.90	0.000051	8262.81	0.65
19.15-19.20	0.0070	71.42	0.000049	5100.81	0.49

19.20-19.25	0.0106	46.87	0.000112	2196.79	0.49
19.25-19.30	0.0149	55.55	0.000222	3085.80	0.82
19.30-19.35	0.0111	89.55	0.000123	8019.20	0.99
19.35-19.40	0.0071	116.27	0.000050	13518.71	0.82
19.40-19.45	0.0068	73.17	0.000046	5353.84	0.49
19.45-19.50	0.0100	65.57	0.0001	4299.42	0.65
19.50-19.55	0.0111	74.62	0.000123	5568.14	0.82
19.55- 20.00	0.1083	46.15	0.011728	2129.82	4.99
Amount	0.7273	4703.8	0.019037	425040.7	55.28

The relationship between these variables forms a linear equation where a and b can be calculated using linear regression. To calculate variables a and b, data from Table 4.83 is used. The linear regression calculation is as follows:

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

= (4703.8*0.019037) – (0.7273*55.28)
(60*0.019037) – (0.7273)2
= 80.452

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

= (60x55.28) – (0.7273 x 4703.8)
(60 x 0.019037) – (0.7273)2
= -169.555

So the linear equation obtained is as follows:
Y = -169.555 + 80.452
Vs = -169.555 + 80.452 D
To obtain the correlation coefficient that occurs in linear regression, it is calculated using the following formula, so that the correlation value obtained is:

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

=(60 x 55.28) – (0.7273 x 4703.8)
√{(60 x 0.019037)- (0.7273)2} x {(60 x 425040.7)-(4703.8)2}
= -0.07246

From the calculations, the value obtained is r = -0.07246, a negative correlation between density and speed which means that when the density value increases, the speed decreases due to pedestrian space and vice versa.

Table 3. Linear Regression Calculation Results

Time (Monday-Wednesday)	D=	Vs= Y	X2	Y2	X*Y
08.45-08.50	0.0028	307.69	0.0000078	94673.14	0.86
08.50-08.55	0.0023	157.89	0.0000052	24929.25	0.36
08.55-09.00	0.0022	277.77	0.0000048	77156.17	0.61
09.00-09.05	0.0016	153.84	0.0000025	23666.75	0.24

09.05-09.10	0.0033	185.18	0.0000108	34291.63	0.61
09.10-09.15	0.0015	250	0.0000022	62500	0.37
09.15-09.20	0.0023	157.89	0.0000052	24929.25	0.36
09.20-09.25	0.0022	277.77	0.0000048	77156.17	0.61
09.25-09.30	0.003	208.33	0.000009	43401.39	0.62
09.30-09.35	0.0031	280	0.0000096	78400	0.86
09.35-09.40	0.0015	166.66	0.0000022	27775.56	0.24
09.40-09.45	0.0022	222.22	0.0000048	49381.73	0.48
09.45-09.50	0.0022	222.22	0.0000048	49381.73	0.48
09.50-09.55	0.0022	166.66	0.0000048	27775.56	0.36
09.55-10.00	0.0008	285.71	0.0000006	81630.2	0.22
Time (Monday-Wednesday)	**D=**	**Vs= Y**	**X2**	**Y2**	**X*Y**
10.00-10.05	0.0007	166.66	0.0000004	27775.56	0.11
10.05-10.10	0.0025	150	0.0000062	22500	0.37
10.10-10.15	0.0031	280	0.0000096	78400	0.86
10.15-10.20	0.0032	230.76	0.0000102	53250.18	0.73
10.20-10.25	0.0015	166.66	0.0000022	27775.56	0.24
10.25-10.30	0.0016	153.84	0.0000025	23666.75	0.24
10.30-10.35	0.0027	181.81	0.0000072	33054.88	0.49
10.35-10.40	0.0016	230.76	0.0000025	53250.18	0.36
10.40-10.45	0.003	250	0.000009	62500	0.75
11.45-11.50	0.0031	440	0.0000096	193600	1.36
11.50-11.55	0.003	500	0.000009	250000	1.5
11.55-12.00	0.0031	440	0.0000096	193600	1.36
12.00-12.05	0.003	625	0.000009	390625	1.87
12.05-12.10	0.0032	461.53	0.0000102	213009.0	1.47
12.10-12.15	0.003	500	0.000009	250000	1.5
12.15-12.20	0.003	458.33	0.000009	210066.4	1.37
12.20-12.25	0.003	458.33	0.000009	210066.4	1.37
12.25-12.30	0.003	583.33	0.000009	340273.9	1.74
12.30-12.35	0.0032	346.15	0.0000102	119819.8	1.10
12.35-12.40	0.003	416.66	0.000009	173605.6	1.24
12.40-12.45	0.0032	538.46	0.0000102	289939.2	1.72
16.30-16.35	0.0022	222.22	0.0000048	49381.73	0.48
16.35-16.40	0.0022	388.88	0.0000048	151227.7	0.85
16.40-16.45	0.0028	260.86	0.0000078	68047.94	0.73
16.45-16.50	0.0022	444.44	0.0000048	197526.9	0.97

16.50-16.55	0.0021	411.76	0.0000044	169546.3	0.86
16.55-17.00	0.0031	280	0.0000096	78400	0.86
17.00-17.05	0.0022	166.66	0.0000048	27775.56	0.36
17.05-17.10	0.0022	333.33	0.0000048	111108.9	0.73
17.10-17.15	0.0031	280	0.0000096	78400	0.86
17.15-17.20	0.0022	222.22	0.0000048	49381.73	0.48
17.20-17.25	0.0022	277.77	0.0000048	77156.17	0.61
17.25-17.30	0.0015	333.33	0.0000022	111108.9	0.49
19.00-19.05	0.0015	166.66	0.0000022	27775.56	0.24
19.05-19.10	0.0007	333.33	0.0000004	111108.9	0.23
19.10-19.15	0.0022	222.22	0.0000048	49381.73	0.48
19.15-19.20	0.0015	250	0.0000022	62500	0.37
19.20-19.25	0.0007	166.66	0.0000004	27775.56	0.11
19.25-19.30	0.0013	384.61	0.0000016	147924.9	0.49
19.30-19.35	0.0015	250	0.0000022	62500	0.37
19.35-19.40	0.0015	416.66	0.0000022	173605.6	0.62
19.40-19.45	0.0022	166.66	0.0000048	27775.56	0.36
19.45-19.50	0.0015	250	0.0000022	62500	0.37
19.50-19.55	0.0016	230.76	0.0000025	53250.18	0.36
19.55- 20.00	0.0015	333.33	0.0000022	111108.9	0.49
Amount	0.1356	17690	0.000339	6080096	42.15

The relationship between these variables forms a linear equation where a and b can be calculated using linear regression. To calculate variables a and b, data from Table 4.84 is used. The linear regression calculation is as follows:

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

$$= \frac{(17690*0.000339) - (0.1356*42.15)}{(60*0.000339) - (0.1356)2}$$

$$= 144.09$$

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

$$= \frac{(60x42.15) - (0.1356 \text{ x } 17690)}{(60 \text{ x } 0.000339) - (0.1356)2}$$

$$= 66697.39$$

So the linear equation obtained is as follows:
Y = 66697.39 + 144.09
Vs = 66697.39 + 144.09 D
To obtain the correlation coefficient that occurs in linear regression, it is calculated using the following formula, so that the correlation value obtained is:

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

$$= \frac{(60 \text{ x } 42.15) - (0.1356 \text{ x } 17690)}{\sqrt{\{(60 \text{ x } 0.000339) - (0.1356)2\} \text{ x } \{(60 \text{ x } 6080096) - (17690)2\}}}$$

$$= 0.4092$$

From the calculations, the value obtained is r = 0.4092, a positive correlation between density and speed, which means that when the density value increases, the speed will also increase and vice versa.

Point 4: Jl. Urip Sumohardjo (Front of Indonesian Muslim University)

Table 4. Linear Regression Calculation Results

Time (Monday-Wednesday)	D=	Vs= Y	X2	Y2	X*Y
08.45-08.50	0.003	400	0.000009	160000	1,2
08.50-08.55	0.002	300	0.000004	90000	0.6
08.55-09.00	0.0026	615.38	0.0000067	378692.5	1.59
09.00-09.05	0.0015	517.42	0.0000022	267723.5	0.77
09.05-09.10	0.0028	285.71	0.0000078	81630.2	0.79
09.10-09.15	0.0016	500	0.0000025	250000	0.8
09.15-09.20	0.0018	333.33	0.0000032	111108.9	0.59
09.20-09.25	0.0018	555.55	0.0000032	308635.8	0.99
09.25-09.30	0.0028	357.14	0.0000078	127549	0.99
09.30-09.35	0.0012	500	0.0000014	250000	0.6
09.35-09.40	0.002	400	0.000004	160000	0.8
09.40-09.45	0.0014	571.42	0.0000019	326520.8	0.79
Time (Monday-Wednesday)	**D=**	**Vs= Y**	**X2**	**Y2**	**X*Y**
09.45-09.50	0.0012	333.33	0.0000014	111108.9	0.39
09.50-09.55	0.0014	428.57	0.0000019	183672.2	0.59
09.55-10.00	0.0012	333.33	0.0000014	111108.9	0.39
10.00-10.05	0.0008	250	0.0000006	62500	0.2
10.05-10.10	0.0018	333.33	0.0000032	111108.9	0.59
10.10-10.15	0.0026	538.46	0.0000067	289939.2	1.39
10.15-10.20	0.0022	454.54	0.0000048	206606.6	0.99
10.20-10.25	0.0018	555.55	0.0000032	308635.8	0.99
10.25-10.30	0.0012	333.33	0.0000014	111108.9	0.39
10.30-10.35	0.003	266.66	0.000009	71107.56	0.79
10.35-10.40	0.002	300	0.000004	90000	0.6
10.40-10.45	0.0026	461.53	0.0000067	213009.9	1.19
11.45-11.50	0.0028	785.71	0.0000078	617340.2	2.19
11.50-11.55	0.0026	923.07	0.0000067	852058.2	2.39

11.55-12.00	0.002	700	0.000004	490000	1.4
12.00-12.05	0.0028	928.57	0.0000078	862242.2	2.59
12.05-12.10	0.0028	571.42	0.0000078	326520.8	1.59
12.10-12.15	0.0024	583.33	0.0000057	340273.9	1.39
12.15-12.20	0.0026	692.30	0.0000067	479279.3	1.79
12.20-12.25	0.0026	692.30	0.0000067	479279.3	1.79
12.25-12.30	0.0026	769.23	0.0000067	591714.8	1.99
12.30-12.35	0.0028	785.71	0.0000078	617340.2	2.19
12.35-12.40	0.0024	833.33	0.0000057	694438.9	1.99
12.40-12.45	0.0028	571.42	0.0000078	326520.8	1.59
16.30-16.35	0.0018	444.44	0.0000032	197526.9	0.79
16.35-16.40	0.0024	750	0.0000057	562500	1.8
16.40-16.45	0.0026	461.53	0.0000067	213009.9	1.19
16.45-16.50	0.0024	416.66	0.0000057	173605.6	0.99
16.50-16.55	0.0012	333.33	0.0000014	111108.9	0.39
16.55-17.00	0.0014	571.42	0.0000019	326520.8	0.79
17.00-17.05	0.0026	692.30	0.0000067	479279.3	1.79
17.05-17.10	0.0024	750	0.0000057	562500	1.8
17.10-17.15	0.002	800	0.000004	640000	1.6
17.15-17.20	0.0024	666.66	0.0000057	444435.6	1.59
17.20-17.25	0.0028	714.28	0.0000078	510195.9	1.99
17.25-17.30	0.0018	888.88	0.0000032	790107.7	1.59
19.00-19.05	0.0012	500	0.0000014	250000	0.6
19.05-19.10	0	0	0	0	0
19.10-19.15	0.0008	500	0.0000064	250000	0.4
19.15-19.20	0.0006	666.66	0.0000036	444435.6	0.39
19.20-19.25	0.0012	333.33	0.0000014	11108.9	0.39
19.25-19.30	0	0	0	0	0
19.30-19.35	0.002	500	0.000004	250000	1
19.35-19.40	0	0	0	0	0
19.40-19.45	0.0012	666.66	0.0000014	444435.6	0.79
Time (Monday-Wednesday)	**D=**	**Vs= Y**	**X2**	**Y2**	**X*Y**
19.45-19.50	0.0006	333.33	0.0000003	111108.9	0.19
19.50-19.55	0.0012	333.33	0.0000014	111108.9	0.39
19.55- 20.00	0.0012	666.66	0.0000014	444435.6	0.79
Amount	0.1133	30750	0.00025149	18486200	63.57

The relationship between these variables forms a linear equation where a and b can be calculated using linear regression. To calculate variables a and b, data from Table 4 is used. The linear regression calculation is as follows:

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

$$= \frac{(30750*0.00025149) - (0.1133*63.57)}{(60*00025149) - (0.1133)2}$$

$$= 3.517$$

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

$$= \frac{(60x63.57) - (0.1133 \times 30750)}{(60 \times 00025149) - (0.1133)2}$$

$$= 0.000219$$

So the linear equation obtained is as follows:
Y = 0.000219 + 3.517
Vs = 0.000219 + 3.517 D
To obtain the correlation coefficient that occurs in linear regression, it is calculated using the following formula, so that the correlation value obtained is:

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

$$= \frac{(60 \times 63.57) - (0.1133 \times 30750)}{\sqrt{\{(60 \times 00025149) - (0.1133)2\} \times \{(60 \times 18486200) - (30750)2\}}}$$

$$= 210.16$$

From the calculations, the value obtained is r = 210.16, a positive correlation between density and speed, which means that when the density value increases, the speed will increase and vice versa. The following is a graph of the relationship between speed-density.

Relationship between Current and Density

From the equation resulting from calculations using linear regression, the relationship between density and speed will be obtained. Meanwhile, from calculations using linear regression, the equation obtained at each point of the research location is:

Location Point Jl. Urip Sumohardjo (Front of the Plantation Service)

Vs = -1642.91 + 173.10 D
So from this equation it is known:
Vf = 173.10
Vf = -1642.91

By substituting variables from the results of the regression equation, it is known that the relationship between flow and density forms the following equation:

Q = -1642.91 + 173.10 D2

From this equation function, a graph of the relationship between density and flow can be created, where density data is described as variable X and flow data as variable Y.

Location Point Jl. Urip Sumohardjo (Front of Primaya Hospital)

Vs = -169.555 + 80.452 D

So from this equation it is known:

Vf = 80.452

Vf = -169.555

By substituting variables from the results of the regression equation, it is known that the relationship between flow and density forms the following equation:

Q = -169.555 + 80.452 D2

From this equation function, a graph of the relationship between density and flow can be created, where density data is described as variable X and flow data as variable Y.

Location Point Jl. Urip Sumohardjo (Front of Bosowa University)

Vs = 66697.39 + 144.09 D

So from this equation it is known:

Vf = 144.09

Vf = 66697.39

DJ

By substituting variables from the results of the regression equation, it is known that the relationship between flow and density forms the following equation:

Q = 66697.39 + 144.09 D2

From this equation function, a graph of the relationship between density and flow can be created, where density data is described as variable X and flow data as variable Y.

Location Point Jl. Urip Sumohardjo (Front of Indonesian Muslim University)

Vs = 0.000219 + 3.517 D

So from this equation it is known:

Vf = 3.517

Vf = 0.000219

By substituting variables from the results of the regression equation, it is known that the relationship between flow and density forms the following equation:

Q = 0.000219 + 3.517 D2

From the function equation, a graph of the relationship between density and flow can be created, where density data is described as variable X and flow data as variable Y. For more details, see Figure 4.30.

Relationship between Current and Speed

To find the relationship between current and speed at each research location point, it can be seen as follows:

Location Point Jl. Urip Sumohardjo (Front of the Plantation Service)

Based on the results of calculations on the relationship between speed and density, it is known that:

Vf = 173.10

Vf = -1642.91

DJ
By substituting Vf, we get:
1642.91 = 173.10
So we get Dj = 9.491

From the results of these calculations, it was found that the density during traffic jams or DJs was 9,491 pedestrians/m2. To find out the relationship between speed and flow, it will be formed using the following formula. Because the density value at traffic jams (Dj) and the space average speed in free flow conditions (Vf) are known, then:

Dj = 9,491 = 0.054
Vf 173.10

By substituting these variables, we obtain the following parabolic equation for the relationship between flow and speed:

Q = 9.491 Vs - 0.054 Vs2

From this equation, a graph of the relationship between speed and flow is created, where the speed data is the X variable and the flow is the Y variable.

Location Point Jl. Urip Sumohardjo (Front of Primaya Hospital)

Based on the results of calculations on the relationship between speed and density, it is known that:

Vf = 80.452

Vf = -169.555

DJ

By substituting Vf, we get:

169,555 = 80,452

DJ

So we get Dj = 2.107

From the results of these calculations, it was found that the density during traffic jams or DJs was 2,107 pedestrians/m2. To find out the relationship between speed and flow, it will be formed using the following formula. Because the density value at traffic jams (Dj) and the space average speed in free flow conditions (Vf) are known, then:

Dj = 2.107 = 0.012
Vf 169,555

By substituting these variables, we obtain the following parabolic equation for the relationship between flow and speed:

Q = 2.107 Vs - 0.012 Vs2

From this equation, a graph of the relationship between speed and flow is created, where the speed data is the X variable and the flow is the Y variable.

Location Point Jl. Urip Sumohardjo (Front of Bosowa University)

Based on the results of calculations on the relationship between speed and density, it is known that:

Vf = 144.09

Vf = 66697.39

DJ

By substituting Vf, we get:

66697.39 = 144.09

So we get Dj = 462.88

From the results of these calculations, it was found that the density during traffic jams or DJs was 462.88 pedestrians/m2. To find out the relationship between speed and flow, it will be formed using the following formula. Because the density value at traffic jams (Dj) and the space average speed in free flow conditions (Vf) are known, then:

Dj = 462.88 = 3.212
Vf 144.09

By substituting these variables, we obtain the following parabolic equation for the relationship between flow and speed:

Q = 462.88 Vs - 3.212 Vs2

From this equation, a graph of the relationship between speed and flow is created, where the speed data is the X variable and the flow is the Y variable.

Location Point Jl. Urip Sumohardjo (Front of Indonesian Muslim University)

Based on the results of calculations on the relationship between speed and density, it is known that:

Vf = 3.517

Vf = 0.000219

DJ

By substituting Vf, we get:

0.000219 = 3.517

DJ

So we get Dj = 6.226

From the results of these calculations, it was found that the density during traffic jams or DJs was 6,226 pedestrians/m2. To find out the relationship between speed and flow, it will be formed using the following formula. Because the density value at traffic jams (Dj) and the space average speed in free flow conditions (Vf) are known, then:

Dj = 6.226 = 1.77
Vf 3,517

By substituting these variables, we obtain the following parabolic equation for the relationship between flow and speed:

Q = 6.226 Vs - 1.77 Vs2

From this equation, a graph of the relationship between speed and flow is created, where the speed data is the X variable and the flow is the Y variable.

Required Sidewalk Width Dimensions

When designing the width dimensions of pedestrian infrastructure, you must pay attention to the minimum standards for designing the width dimensions of pedestrian infrastructure. The width of the pedestrian network based on land use type can be seen in table 5 below:

Table 5. Pedestrian Network Width According to Land Use

Land Use	Minimum Width (m)	Recommended Width (m)
Housing area	1.6	2.75
Office	2	3
Industry	2	3
School	2	3
Terminal/bus stop/TPKPU	2	3
Shops/shopping/entertainment	2	4
Bridges, Tunnels	1	1

4. Conclusion

From the results and discussion it can be concluded that the characteristics of pedestrian movement when walking on the pedestrian road on the elevated toll road section of Jl. Urip Sumoharjo Makassar is relatively small, because data on pedestrian flow and density on average only reaches 3-4 pedestrians/minute/m. The

relationship between variables obtained through calculations using the greenshield method on pedestrian roads on the road sections around the Jalan Urip Sumohardjo Makassar flyover shows the relationship between the variables of flow, speed and density. The results of the analysis of the planned sidewalk width for pedestrian roads on the road sections around the Jalan Urip Sumohardjo Makassar elevated toll road based on the provisions of Minister of Public Works Regulation No. 03/PRT/M/2014 is very far from the ideal standard for pedestrian paths for office and educational areas or schools, namely < 3 meters and plans to expand or widen pedestrian paths cannot be applied to pedestrian paths in the 4 research locations. Because it is not possible to widen the sidewalks on the sidewalks in front of the Plantation Service and in front of the Primaya Hospital and it is only slightly possible to widen the sidewalks on the Bosowa University and Indonesian Muslim University campuses, other alternative solutions are needed. The level of service (level of service) for pedestrian roads on the road sections around the Jalan Urip Sumohardjo Makassar Laying Toll Road is reviewed based on pedestrian flow and space in accordance with Minister of Public Works Regulation No. 03/PRT/M/2014 obtained standard A for pedestrian flow but standard D for sidewalk area at 4 research locations.

References

[1] Trianingsih, L. and Hidayah, R. "Analisis Perilaku Pejalan Kaki Pada Penggunaan Fasilitas Penyeberangan Di Sepanjang Jalan Kawasan Malioboro Yogyakarta," *Inf. dan Ekspose Has. Ris. Tek. Sipil dan Arsit.*, vol. 10, no. 2, 2014.

[2] Rohmawati, T. and Natalia, T. W. "Level of Pedestrian Satisfaction with Sidewalks in Bandung City," *J. Polit. Sci. Commun.*, vol. 8, no. 1, 2018, doi: 10.34010/JIPSI.V8I2.1332.

[3] Permana, Irsan, Susetyaningsih, Adi., & Farida, I. "Evaluasi Jalur Pejalan Kaki Dengan RTH Pada Ruas Jalan Ahmad Yani Kec. Garut Kota," *J. Konstr. Sekol. Tinggi Teknol. Garut*, 2016.

[4] Dariman, R.T. "Studi Karakteristik Pedestrian Pada Manajemen Lalu Lintas Di Kampus Unhas Tamalanrea," *Fak. Tek. Sipil Univ. Hasanuddin.*, 2021.

[5] Ishak, S. "Tingkat Pelayanan Serta Ketersediaan Sarana dan Prasarana Pejalan Kaki di Pantai Losari Kota Makassar," *J. Transp. Progr. Magister Tek. Perenc. Transp. Univ. Hasanuddin.*, 2012.

[6] Frans, "Persepsi Pejalan Kaki terhadap Keamanan dan Kenyamanan Jalur Trotoar di Pusat Kota Amurang," *J. Arsit. Daseng. Univ. Sam Ratulangi. Manad.*, 2016.