



Pedestrian Facility Analysis For Utilization and Comfort (Case Study of Bekasi Highway Km.18)

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Abstract

As the population continues to grow, it results in a lot of human mobility. However, the high mobility is not matched by transportation facilities and infrastructure services, especially the sidewalks. One of the areas with existing sidewalk problems is Bekasi Highway KM. 18. The problems that occur are that the sidewalks are used as a place to sell street vendors, are used as illegal parking lots and the unavailability of guide tiles for persons with disabilities. The methodology of this research is carried out by conducting geometric surveys, measuring the volume and travel time of pedestrians to determine service levels and distribute questionnaires to 63 respondents to pedestrians in finding the level of performance and the importance of sidewalk facilities. The processing of this data uses Microsoft Excel and the Statistical Package for the Social Sciences (SPSS) using the Importance Performance Analysis (IPA) method. The results of the analysis carried out by geometric surveys show that the sidewalks have not met the minimum standards according to regulations. From the measurement results of the volume and travel time of pedestrians, the service level is obtained with category B, as well as the results of the questionnaire related to the level of performance and the importance of sidewalk facilities, namely quadrant I there is Circulation, Climate, Shape, Safety, Cleanliness, Beauty, in quadrant II there is Circulation, Noise, Smells, Cleanliness and in quadrant III there is Circulation, Noise, and Cleanliness.

Keywords:

Importance Performance Analysis, Pedestrians, Performance Levels, Service Levels, Sidewalks

1. Preliminary

A long with the population that continues to increase, it results in a lot of human mobility. Unfortunately, this high mobility is not matched by transportation facilities and infrastructure, especially sidewalks. Even though the provision of safe sidewalks can prevent accidents for pedestrians (Institute for Transportation Development Policy. Pedestrian Facilities Design Guidelines: 2019). Based on the WHO Report (World Health Organization 2013). The number of pedestrian accident victims in the world is 273,000 or 22% of the total traffic accidents according to the type of road users globally. One of the areas with existing sidewalk problems is Bekasi Highway KM.18 Pulogadung, East Jakarta. there are sidewalks that are used as a place to sell street vendors, used as illegal parking lots, there are no guide floor paths for persons with disabilities and sidewalk facilities that are not completely connected.

The purpose of writing this research is want to know whether the existing pedestrian facilities are in accordance with their function for pedestrians, to know the level of use and performance of sidewalk services and to know the steps taken towards the analysis of the use and comfort of sidewalk facilities on Bekasi Highway KM.18 Pulogadung, East Jakarta.

2. Literature Review

Pedestrians are people who carry out walking activities and are one of the elements of road users. (Areas 1997). Pedestrian ways intended for pedestrians or wheelchairs for persons with disabilities, the elderly and the blind are designed based on the minimum space requirements to move safely, freely and unobstructed (Areas 1997).

As for sidewalks, it is defined as part of the road provided for pedestrians (Gunawan, Wibowo 1988). Generally placed parallel to the traffic lane, and must be separated from the traffic lane by a physical structure. From this definition, it says that a sidewalk is a place to walk that is adjacent to a highway. The main functions of a sidewalk are:

- a. As a separator between vehicle lanes and pedestrians
- b. As a pedestrian path that plays a role in connecting between functional places with other functional places.
- c. As a transit place, where on the sidewalk there are bus stops, rest areas and others
- d. As a place for pedestrian movement, which allows pedestrians to carry out various activities.

2.1. Comfort

Mark S. Sanders (1993) describes the concept of comfort that comfort is a condition of feeling and is very dependent on the person experiencing the situation. In this case we cannot know the level of comfort that other people feel directly or by observation but must ask the person directly about how comfortable they are, usually by using certain terms with a determined level. According to the practitioner of designing public spaces and landscapes, Hakim (2014) argued that the elements that affect comfort include:

- a. Circulation
- b. Climate or Natural Forces
- c. Noise
- d. Smells
- e. Shape
- f. Security
- g. Cleanliness
- h. Beauty

2.2. Pedestrian Flow, Speed, Density and Space

Flow is the volume of pedestrians crossing a certain area within a specified period of time. The pedestrian flow formula is in Equation 1.

$$Q_{15} = \frac{Nm}{15 \cdot W_E} \dots\dots\dots(1)$$

(Source: (Transportation Research Board 1985))

Where:

- Q₁₅: Pedestrian flow 15 minute interval (pedestrian / meter / minute)
- Nm: The greatest number of pedestrians at a time interval of 15 minutes (pedestrians / 15 minutes)
- W_E: Effective width of sidewalk facilities (meters)

The provisions for the Effective Width (W_E) can be determined through Equation 2

$$W_E = W_T - W_o \dots\dots\dots(2)$$

Where:

- W_E: Effective width of sidewalk facilities (meters)
- W_T: Total width of sidewalk facilities (meters)
- W_o: Width of obstacles / obstacles at sidewalk facilities

Speed is the time taken by pedestrians within a predetermined distance. The pedestrian speed formula is in Equation 3

$$v = \frac{L}{t} \dots\dots\dots(3)$$

(Source: (Fred L. Mannering 1988))

Where:

- V: Pedestrian speed (m / sec)
- L: Observation distance (m)
- t: Travel Time (m / sec)

Density is the number of pedestrians in a space to walk at a specified distance and time. The pedestrian density formula is in Equation 4

$$D = \frac{Q}{V} \dots\dots\dots(4)$$

(Source: (Garber and Hoel 2009))

Where:

- D: Density (pedestrians / m²)
- Q: Pedestrian flow (pedestrians / minute / meter)
- V: Pedestrian speed (m / s)

Pedestrian space is the amount of pedestrian area available to pedestrians. The pedestrian space formula is in Equation 5

$$S = \frac{1}{D} \dots\dots\dots(5)$$

(Source: (Transportation Research Board 2000))

Where:

- S: Pedestrian space (m² / pedestrian)
- D: Density (pedestrians / m²)

2.3. Service Standard

Service Standards are benchmarks that are used as guidelines for service delivery and reference for assessing service quality as obligations and promises of administrators to the public in the context of quality, fast, easy, affordable, and measurable services. (UU Pelayanan Publik (UU No. 25/2009) 2009).

In the implementation of service standards, of course, have service level criteria that must be met. The criteria for the service level of sidewalk facilities are in the Minister of Public Works Regulation (Guidelines for Planning 2014) are as follows:

- Standard A, pedestrians can walk freely, including being able to determine the direction of walking freely, at a relatively fast speed without causing interference between pedestrians. Pedestrian path area ≥ 12 m² / person with pedestrian flow < 16 people / minute / meter.
- Standard B, pedestrians can still walk comfortably and quickly without disturbing other pedestrians, but the presence of other pedestrians has started to affect the flow of pedestrians. Pedestrian path area ≥ 3.6 m² / person with pedestrian flow $< 16-23$ people / minute / meter.
- Standard D, pedestrians can walk with a normal current, but must frequently change positions and change speed because the opposite flow of pedestrians has the potential to cause conflict. Pedestrian path area $\geq 1,2-2,1$ m² / person with pedestrian flow $< 33-49$ people / minute / meter.
- Standard E, pedestrians can walk at the same speed, but the movement will be relatively slow and irregular when many pedestrians turn around or stop. Pedestrian path area $\geq 0.5-1.3$ m² / person with pedestrian flow $> 49-75$ people / minute / meter.
- Standard F, pedestrians walk at a very slow and limited current speed due to frequent conflicts with one-way or opposite pedestrians. Standard F is no longer comfortable and is no longer in accordance with the pedestrian space capacity. Pedestrian path area < 0.5 m² / person with varying pedestrian flows.

2.4. IPA Method

IPA (Importance Performance Analysis) is used to map the relationship between performance and the importance of each attribute offered and the gap between performance and expectations of the attributes that have been determined. In this technique, respondents are asked to rate the level of performance and importance of the services provided by the service provider.

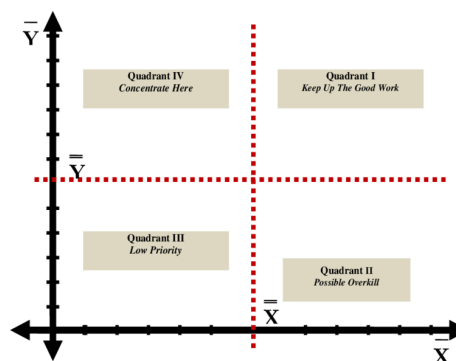


Figure 1. Cartesius Diagram of the Natural Science Method
 (Source: (Supranto 2011))

The explanation of the Cartesian quadrant diagram is as follows:

- Quadrant I (Top Priority)**
 In this quadrant, there are things that are considered important and expected by service users, but the performance provided by service providers to users is not satisfactory, so the performance needs to be improved to satisfy service users.
- Quadrant II (Maintain Achievement)**
 In this quadrant there are things that are considered important and expected by service users and have high performance so that it needs to be maintained by service providers.
- Quadrant III (Low Priority)**
 In this awareness there are things that are considered to have a low level of performance and are less important or not really expected by service users so that service providers do not need to prioritize or pay more attention to these things.

d. Quadrant IV (Excessive)

In this awareness there are things that are considered not too important and that are not really expected by service users so that service providers are better off diverting things that are included in these factors to factors that have a higher priority level.

3. Methodology

The research method is a branch of science that discusses or questions the ways of carrying out research (which includes the activities of searching, taking notes, formulating, analyzing and following reports) based on scientific facts or symptoms. (Wirartha 2006).

As for this research method using quantitative methods by carrying out 3 stages, namely geometric surveys, measuring the volume and travel time of pedestrians and by distributing questionnaires.

3.1. Site Survey and Geometric Conditions

The location survey is an important activity carried out in the implementation of research. The thing that needs to be done in a location survey is observing the geometric conditions of sidewalk facilities using a checklist in accordance with the Regulation of the Minister of Public Works (Guidelines for Planning 2014).

Table 1. Field Survey Checklist

No	Trotoar Elements	West Side		East Side	
		According To Standards	Does Not Comply With The Standards	According To Standards	Does Not Comply With The Standards
1	Pedestrian Way				
A	Minimum curb width (2 meters)				
B	Pedestrian elevation elevation with motorized vehicle lanes (0.2 meters)				
C	Pedestrian elevation elevation with green lane (0.15 meters)				
D	The minimum distance between the pedestrian path and buildings (0.75 meters)				
E	Slope of longitudinal curb (8%)				
F	Pavement slope (2-4%)				
2	Pedestrian Way with Difability				
A	Walkway Width (1.5 meters)				
B	Minimum sidewalk area (2.25 meters)				
C	Avoid various hazards that could potentially threaten safety such as bars and holes				
D	The sidewalk level should make it easier to cross the road				
		West Side		East Side	
No	Trotoar Elements	According To Standards	Does Not Comply With The Standards	According To Standards	Does Not Comply With The Standards
E	Equipped with guide tracks and guide tiles to show various				

changes in curb texture

- F The road surface is not slippery
 - G. A ramp is located at every intersection and crossing points
 - H Pedestrian ways for people with disabilities are placed along the pedestrian network infrastructure
 - 3 Street Furniture Way
 - A Street furniture lane width (0.6 m)
 - B Width of road furniture if planted with plants (1.5 m)
 - C The difference between the maximum height of the sidewalk and the road furniture lane (0.15 m)
-

As for the location survey using tools, including:

- a. Wheel Meter
- b. Meter
- c. Stationary
- d. Camera
- e. Computer

3.2. Measurement of Pedestrian Volume and Travel Time

Measuring the volume of pedestrians by counting the number of pedestrians crossing the sidewalks at Bekasi Highway KM. 18 Palad Street- Intersection Pulo Lentut Street Pulogadung Industrial Estate, East Jakarta. As for measuring pedestrian travel time by calculating the travel time taken by pedestrians at Bekasi Highway KM. 18 Intersection Palad Street-Intersection Pulo Lentut Street, Pulogadung Industrial Estate, East Jakarta. The data collection time in the field is carried out 3 days a week, namely Monday, Friday and Sunday at 06.00-08.00 WIB and afternoon days at 16.00-18.00 WIB.

3.3. Questionnaire

The questionnaire is a data collection technique which is done by giving a set of questions or statements in writing to the respondent to answer (PD Sugiyono 2017). Therefore, the researcher is obliged to prepare a list of questions that will be given to respondents regarding the research problem.

Put a mark (v) according to the choice of the father / mother / brother in the column: 1. Performance Level; VNG: Very Not Good, NG: Not Good, QG: Quite Good, G: Good, VG: Very Good 2. Level of Importance; VNI: Very Not Important, NI: Not Important, QI: Quite Important, I: Important, VI: Very Important		Performance Level					Level of Importance				
		VNG	NG	QG	G	VG	VNI	NI	QI	I	VI
ALPHABET	A LIST OF QUESTIONS	1	2	3	4	5	1	2	3	4	5
X.1	CIRCULATION										
X.1.1	The role of the sidewalk as a link between regional spaces										
X.1.2	Current conditions of sidewalks for pedestrian users										
X.1.3	The current condition of the sidewalks for pedestrians with special needs										
X.1.4	The role of sidewalks as a space for social interaction										
X.1.5	The condition of the sidewalks against other activities that can hinder activities such as trading and parking										
X.2	CLIMATE										
X.2.6	The role of sidewalks in protecting pedestrians from rain										
X.2.7	The role of sidewalks in protecting pedestrians from sunlight										
X.3	NOISE										
X.3.8	Noise level in the environment around the sidewalk										
X.3.9	The role of plants on the sidewalk that can reduce noise										
X.4	SMELLS										
X.4.10	The condition of the landfill around the sidewalk										
X.4.11	Condition of drains around the sidewalk										
X.4.12	Activity conditions that cause scents and smells around the sidewalk										
X.5	SHAPE										
X.5.13	The current form of sidewalks for pedestrians										
X.5.14	The shape of the pavement surface layer for pedestrian comfort										
X.5.15	Level of curb height between sidewalks and motorized vehicle lanes										
X.5.16	The degree of slope of the longitudinal and transverse sidewalks against pedestrians										
X.6	SECURITY										
X.6.17	The safety level of sidewalks against motorized vehicles										
X.6.18	The level of safety of pedestrians against disturbance due to other activities on the sidewalk										
X.7	CLEANLINESS										
X.7.19	Cleanliness level on sidewalks										
X.7.20	The existence of trash bins around the sidewalk										
X.7.21	The condition of the trees on the cleanliness of the sidewalk										
X.7.22	Cleanliness of drainage around sidewalks										
X.8	BEAUTY										
X.8.23	The level of beauty of the sidewalk to its current form										
X.8.24	The level of plant composition on the beauty of the sidewalk										
X.8.25	The composition of street furniture to the beauty of the sidewalk										

Figure 2. Questionnaire

The number of samples used in filling out the questionnaire was 63 respondents using the Slovin formula in equation 6.

$$n = \frac{N}{(1+N(e)^2)} \dots \dots \dots (6)$$

Where :

- n: Number of Samples
- N: Total Population
- e: Error Tolerance Limit

4. Results and Analysis

4.1. Geometric Conditions

The geometric survey was conducted to determine the existing physical conditions at the site with the standard service for sidewalk facilities contained in the Minister of Public Works Regulation. (Guidelines for Planning 2014) and other laws and regulations. The results of the investigation of the geometric conditions in Bekasi Highway KM.18 Pulogadung, East Jakarta are shown in Table 2.

Table 2. Investigation Results of Sidewalk Geometric Observations

No	Trotoar Elements	West Side		East Side	
		According To Standards	Does Not Comply With The Standards	According To Standards	Does Not Comply With The Standards
1	Pedestrian Way				
A	Minimum curb width (2 meters)	X	√	x	√
B	Pedestrian elevation with motorized vehicle lanes (0.2 meters)	X	√	x	√
C	Pedestrian elevation with green lane (0.15 meters)	X	√	√	x
D	The minimum distance between the pedestrian path and buildings (0.75 meters)	X √	√	X	√
E	Slope of longitudinal curb (8%)		x	x	
F	Pavement slope (2-4%)		x	x	

No	Trotoar Elements	West Side		East Side	
		According To Standards	Does Not Comply With The Standards	According To Standards	Does Not Comply With The Standards
2	Pedestrian Way with Difability				
A	Walkway Width (1.5 meters)		x	x	
B	Minimum sidewalk area (2.25 meters)	√	x	x	√
C	Avoid various hazards that could potentially threaten safety such as bars and holes	x	√	x	√
D	The sidewalk level should make it easier to cross the road	√	x	x	√
E	Equipped with guide tracks and guide tiles to show various changes in curb texture	x	√	x	√
F	The road surface is not slippery		x		x
G	A ramp is located at every intersection and crossing points	√	√	√	√
H	Pathways for people with disabilities are placed along the pedestrian network infrastructure	x	√	x	√
3	Street Furniture Way				
A	Street furniture lane width (0.6 m)	√	x	√	x
B	Width of road furniture if planted with plants (1.5 m)	x	√	x	√
C	The difference between the maximum height of the sidewalk and the road furniture lane (0.15 m)	√	x	x	√

From the results of the investigation of observation geometric conditions of the sidewalks in the field, there were many found sidewalk conditions that did not meet service standards with different levels of problems on the west and east sides of Bekasi Highway KM.18 Pulogadung, East Jakarta. In general, the problem occurs, namely the minimum distance of the walkway feet with buildings, height of vertical barriers and completeness of guide paths for pedestrians with special needs. it can be seen in Figure 3.

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Figure 3. Geometric Measurement Survey

4.2. Level Of Services

Level of services calculation is carried out by calculating the volume and travel time of pedestrians crossing the sidewalk on Bekasi Highway KM.18 on April 24, April 26 and May 4 2020 in the morning (06.00-08.00) and evening (16.00 -18.00) The results of pedestrian volume observations are shown in Figure 4.

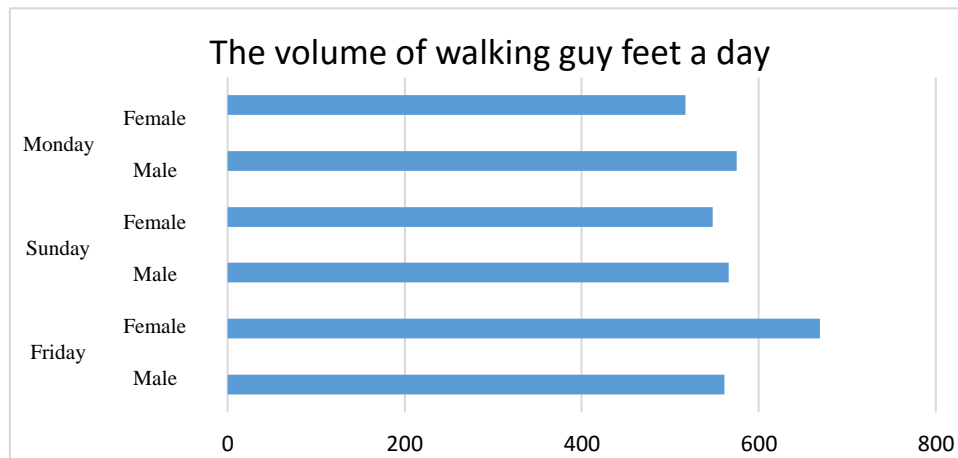


Figure 4. Pedestrian Volume Chart per Day

According to field observations, the peak volume of pedestrians on the west side of Bekasi Highway KM.18 is on Friday afternoon at 17.16-17.30 WIB with a volume of 60 Pedestrians and on the east side at 17.00-17.15 WIB with a volume of 67 Pedestrians .

The calculation of pedestrian speed is done by calculating the travel time of pedestrians crossing the sidewalk at the point that is most traversed by pedestrians. The results of the calculation of pedestrian speed at peak hours are shown in table 3.

Table 3. Pedestrian Speed Data

No.	Location	Number of Pedestrians		Average Speed (m / s)		Average Combined Velocity (m / s)	Combined Average Speed (m / min)
		Male	Women	Male	Women		
1.	West side of Bekasi Highway KM. 18	38	22	1.27	1.23	1.26	75.83
2.	East side of Bekasi Highway KM. 18	37	30	1.36	1.10	1.25	74.91

From the results of the calculation of pedestrian flow, speed, density and space shown in Table 3, it is known that the level of services on the West and East sides of Bekasi Highway KM.18 is "B" in accordance with the Minister of Public Works Regulation. (Guidelines for Planning 2014).

4.3. Questionnaire Data Analysis

Analysis of questionnaire data in this study using the IPA method. This was done to find out the respondent's opinion regarding the performance and importance of the condition of the object in question. The respondents referred to in this study were pedestrians who use sidewalk facilities on Bekasi Highway KM.18 Pulogadung, East Jakarta. From the results of respondents' assessment of the questionnaire, the level performance and interests in the form of a Cartesian diagram shown in Figure 5.

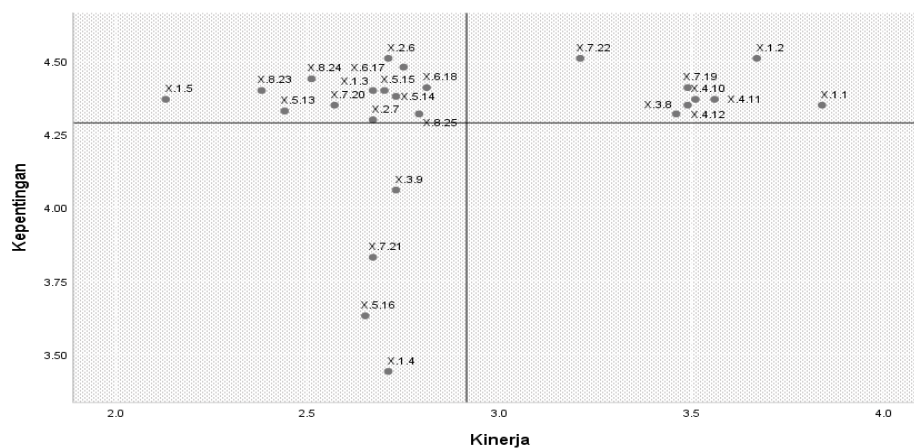


Figure 5 Kartecius Diagram of Performance and Interest Levels

After obtaining the results from the Kartecius diagram shown in Figure 4, the level of performance and importance of sidewalk facilities can be determined, among others, as follows:

A. Quadrant I (Top Priority)

The elements contained in Quaternary I include:

- a. Current sidewalk conditions for pedestrians with special needs (X.1.3)
- b. The condition of the sidewalk towards other activities that can hinder such as trading and parking (X.1.5)
- c. Role of sidewalks in protecting pedestrians from rain (X.2.6)
- d. The role of sidewalks in protecting pedestrians from sunlight (X.2.7)
- e. Current form of sidewalks for pedestrians (X.5.13)
- f. The shape of the pavement surface layer for pedestrian comfort (X.5.14)
- g. Level of curb height between sidewalks and motorized vehicle lanes (X.5.15)
- h. The level of safety of pedestrians against motorized vehicles (X.6.17)
- i. Pedestrian safety level against disturbance due to other activities on the sidewalk (X.6.18)
- j. The existence of trash cans around the sidewalk (X.7.20)
- k. The level of beauty of the pavement against its current form (X.8.23)
- l. The level of plant composition on the beauty of the sidewalk (X.8.24)
- m. The composition of street furniture to the beauty of the sidewalk (X.8.25)

B. Quadrant II (Maintain Achievement)

The elements contained in Ku Consciousness II include:

- a. The role of the sidewalk as a link between regional spaces (X.1.1)
- b. Current condition of sidewalks towards pedestrians (X.1.2)
- c. Sound level in the environment around sidewalks (X.3.8)
- d. Condition of landfills around sidewalks (X.4.10)
- e. Condition of drains around sidewalks (X.4.11)
- f. Activity conditions that give rise to scents and smells around the sidewalk (X.4.12)
- g. Cleanliness level on sidewalks (X.7.19)
- h. Cleanliness of drainage around sidewalks (X.7.22)

C. Quadrant III (Low Priority)

The elements contained in Ku consciousness III include:

- a. The role of sidewalks as a space for social interaction (X.1.4)
- b. The role of plants on sidewalks that can reduce noise (X.3.9)
- c. Slope level of longitudinal and transverse sidewalks against pedestrians (X.5.16)
- d. Condition of trees on sidewalk cleanliness (X.7.21)

5. Conclusion

From the results of this study it can be concluded that :

The sidewalk is located on Bekasi Highway KM. (Intersection Pulo Lentut Street-Intersection Palad Street) has been used by pedestrians but has not been able to be felt optimally. This is because there are other activities on the sidewalk such as parking and the presence of street vendors that hinder pedestrians. as well as several sidewalk facilities that are not in accordance with the Minister of Public Works (Guidelines for Planning 2014).

1. During the Covid-19 pandemic, the sidewalk located on Bekasi Highway KM.18 (Simpang Jl.Pulo Lentut Industrial Estate Pulogadung-Simpang Jl.Palad) had a service usage level of the "B" category (Good) with an average level of comfort, performance and interest assessment of 67.93% (Quites Good)
2. Steps taken on the results of analysis of the use and comfort of the sidewalk on Bekasi Highway KM 18, namely:
 - a. There needs to be an increase in facility services in accordance with the Minister of Public Works (Guidelines for Planning 2014).
 - b. There needs to be an increase in the performance of sidewalk services for items contained in Quaternary I from the analysis of the IPA method.

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