

Improving Pedestrian Facilities to Support Public Mobility in Bengkulu City

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Article Info

Article history:

Received Jun 12th, 2026

Revised Aug 10th, 2026

Accepted Aug 20th, 2026

Keyword:

Pedestrian facilities, accessibility, walkability index, level of service, pedestrian safety.

ABSTRACT

A Pedestrian facilities are a crucial component in realizing a safe, comfortable, and sustainable urban transportation system. However, the condition of pedestrian facilities in Bengkulu City still faces various problems that reduce the level of safety, comfort, and accessibility for users. These problems include damaged sidewalks, sidewalk use by street vendors and vehicle parking, and limited supporting facilities for pedestrians. This study aims to identify the existing condition of pedestrian facilities, analyze the level of accessibility, and propose a safe pedestrian facility design in accordance with Circular Letter Number 18/SE/Db/2023 concerning Guidelines for Technical Planning of Pedestrian Facilities. The study was conducted on six main roads in Bengkulu City using a mixed method through pedestrian interviews, Level of Service analysis, and Walkability Index calculations. The results showed that the condition of pedestrian facilities experienced 446.5 meters of damaged sidewalks and obstacles that reduced the effective width of pedestrian paths. The LOS analysis showed that several road sections were at level F of service, reflecting limited space for pedestrian movement. Meanwhile, the Walkability Index value on all road sections was in the inadequate category with a value range of 30.61–49.11. Based on these results, it is necessary to improve the quality of pedestrian facilities through revitalizing sidewalks, providing safe crossing facilities, adding supporting facilities, and regulating activities that disrupt the function of sidewalks to improve the safety and comfort of pedestrians in Bengkulu City.



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INTRODUCTION

Walking is an important component of the urban transportation system that supports safe, healthy and sustainable community movement. (Muliasari et al., 2022) Walking is a form of active transportation that can reduce dependence on motorized vehicles while providing benefits to physical health and the urban environment (Setiawan et al., 2025). The quality of the walking environment is influenced by the availability of infrastructure that is safe, comfortable, and easily accessible to all road user groups (Schouten et al., 2025). Various studies have shown that adequate pedestrian facilities can increase walking activity and strengthen social and economic interactions in urban communities (Stefanidis & Bartzokas-Tsiompras, 2024). To measure the quality of the walking environment, the concept of walkability is widely used as an indicator that reflects the level of accessibility, comfort, safety, and connectivity of an area for pedestrians (Debora Wowor et al., 2019). Previous research has also shown that increasing walkability values contributes to the creation of healthier, more inclusive, and sustainable cities (Soo et al., 2025). Therefore, evaluating pedestrian facilities is an important step in supporting the development of an urban transportation system that is oriented towards the needs of non-motorized road users.

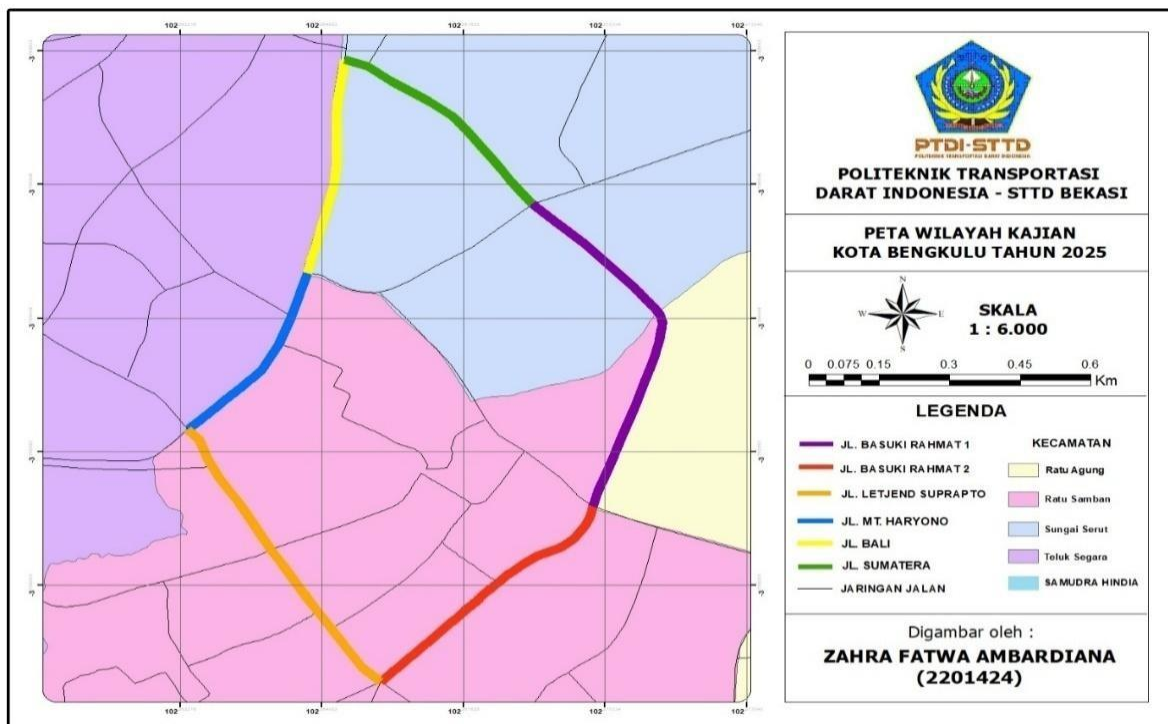
As the center of activity and government in Bengkulu Province, Bengkulu City faces various problems in pedestrian facilities, especially on the main road corridors. The existing condition shows the existence of damaged sidewalks along 446.5 meters, obstructions on pedestrian paths due to trading activities and vehicle parking, and the failure to meet technical standards for pedestrian facilities according to applicable guidelines. These problems reduce the level of safety, comfort, accessibility, and smooth movement of pedestrians, especially for vulnerable groups such as children, the elderly,

and people with disabilities. Based on these conditions, this study aims to identify the existing condition of pedestrian facilities, analyze the level of accessibility using the Walkability Index approach, and develop a design proposal for improving pedestrian facilities that are safe and in accordance with the existing guidelines.

RESEARCH METHODS

Place and Time of Research

This research was conducted on six main roads in Bengkulu City, namely Jalan Basuki Rahmat 1, Jalan Basuki Rahmat 2, Jalan Letjend Suprpto, Jalan MT. Haryono, Jalan Bali, and Jalan Sumatera which are the corridors of urban activity centers with land use characteristics in the form of commercial, office, educational, and residential areas. The study area was chosen because it has high pedestrian activity and various problems were found in pedestrian facilities such as damaged sidewalks, sidewalk occupancy by street vendors and vehicle parking, and non-compliance of facilities with applicable technical standards.



Picture 1 Map of the study location

Data collection technique

Primary data was obtained from various surveys, including:

- Road Section Inventory Survey**
Data collection activities regarding the physical condition and equipment of a road section to determine the existing characteristics of the road
- Traffic Counting Survey**
Data collection activities are carried out by recording the number of vehicles passing the observation point on the road section that is the study location.
- Pedestrian Crossing and Walking Survey**
This was done by recording the number of pedestrians walking along the sidewalk and crossing the road at the study location (Setiadi et al., 2022). Recording was conducted over a 2-hour period with 15-minute intervals during each busy period and differentiated based on the direction of movement.
- Pedestrian interview survey**
Interviews were conducted to explore pedestrians' perceptions of the condition of available pedestrian facilities.

Secondary data was obtained from various local government agencies. The target data collected were:

- Administrative map of Bengkulu city
- Road Network Map

Data Analysis Techniques

1. Level of Service for Pedestrian Facilities

Analysis of the level of service of pedestrian facilities is a stage for understanding the behavioral patterns and needs of road users which refers to Peraturan Menteri Pekerjaan Umum Nomor 03/PRT/M/2014 Tentang Pedoman Perencanaan, Penyediaan, Dan Pemanfaatan Prasarana Dan Sarana Jaringan Pejalan Kaki Di kawasan Perkotaan

Table 1. Level of service of pedestrian facilities

Service Level	Pedestrian Path (m ² /person)	Average speed (meters/minute)	Pedestrian flow volume (people/meter/minute)	Volume/ capacity Ratio
A	≥ 12	≥ 78	≤ 6.7	≤ 0.08
B	≥ 3.6	≥ 75	≤ 23	≤ 0.28
C	≥ 2.2	≥ 72	≤ 33	≤ 0.40
D	≥ 1.4	≥ 68	≤ 50	≤ 0.60
E	≥ 0.5	≥ 45	≤ 83	≤ 1.00
F	< 0.5	< 45	Variables	1.00

Source: PM PU No. 03/PRT/M/2014

2. Pedestrian characteristics and perceptions

This study was conducted to determine the characteristics of pedestrian facility users and public perceptions regarding their use. The scale used was a Likert scale of 1-5. The sample was obtained using the Cochran formula.

$$n = \frac{Z^2 pq}{e^2}$$

Information:

n = Sample size

Z² = Confidence level value (90% = 1.65; 95% = 1.96; 99% = 2.58)

p = Probability of being correct (0.5)

q = Probability of being wrong (0.5)

e = margin of error (maximum 10%)

Thus, a sample of pedestrian interviews was obtained:

$$n = \frac{(1,96)^2 \times (0.5) \times (0.5)}{(0.1)^2}$$

$$n = \frac{0.9604}{0.01}$$

$$n = 96.04 = 100$$

Thus, the number of samples obtained in this study was 96 respondents which was then rounded up to 100 respondents.

3. Assessment of feasibility index walking (walkability index)

Refers to Surat Edaran Nomor No. 15/SE/DB/2023 Tentang Pedoman Penentuan Index Kelayakan Berjalan (Walakability Index) Di kawasan Perkotaan

$$\text{Skor Segmen} = \sum_{f=1}^n (\text{nilai} * \text{bobot})$$

$$\text{Skor Jarak} = \text{Skor Segmen} \times \text{Panjang Segmen}$$

$$\text{Index kelayakan berjalan} = \frac{\sum \text{Skor jarak}}{\sum \text{Panjang Segmen}} \times 100$$

The index obtained can represent the condition of pedestrian facilities, then grouped into five three categories, namely:

Table 2. Running feasibility index category

Value Range	Category	Condition
> 80 - 100	Very Adequate	Describes the conditions of accessibility and convenience, safety, and completeness of existing facilities which are very adequate for pedestrians.
> 65 - 80	Adequate	Describes the conditions of accessibility and ease, safety, and completeness of existing facilities that are adequate for pedestrians.
> 50 - 65	Enough Adequate	Describe condition accessibility and convenience , safety , and completeness existing facilities Enough adequate for pedestrian .
> 30 - 50	Insufficient	Describes the condition of accessibility and ease, safety, and the completeness of existing facilities which are inadequate for pedestrians.
< 30	Absolutely Not Adequate	Describes the conditions of accessibility and ease, safety, and completeness of existing facilities as very inadequate for pedestrians.

Source: Circular Letter of the Minister of Public Works and Public Housing No. 15/SE/DB/2023

4. Need for facilities for crossing

The following are the technical provisions regarding the minimum width of pedestrian paths or sidewalks that have been regulated according to Circular Letter Number 18/SE/DB/2023 concerning Guidelines for Technical Planning of Pedestrian Facilities.

$$W = \frac{V}{35} + N$$

Information:

W = is the minimum effective width of the sidewalk (m)

V = is the planned/two-way pedestrian volume (people/meter/minute)

N = is the additional width according to local conditions (meters), determined in Table

Table 3 N value

N (meters)	Condition
1.5	Roads in areas with high pedestrian traffic**
1.0	Roads in areas with moderate pedestrian traffic***
0.5	Roads in areas with low pedestrian traffic****

Source: Circular Letter of the Minister of Public Works and Public Housing No. 18/SE/DB/2023

Besides sidewalks, pedestrian facilities that require attention are crossings. Determining the need for crossing facilities is based on the following formula:

$$P \times v^2$$

Information:

P = A pedestrian crossing traffic flow along 100 meters (people/hour)

V = Two-way vehicle traffic flow per hour, expressed (vehicles/hour)

Table 4 Criteria for determining level crossing facilities

P (person/hour)	V (vehicle /hour)	PV ²	Recommendation
50 – 1100	300 – 500	> 10 ⁸	Zebra crossing or pedestrian platform **
50 – 1100	400 – 750	> 2 x 10 ⁸	Zebra crossing with waiting stalls
50 - 1100	>500	> 10 ⁸	Pelican
> 1100	>300		
50 – 1100	>750	> 2 x 10 ⁸	Pelican with waiting stalls
> 1100	>400		

Source: Circular Letter of the Minister of Public Works and Public Housing No. 18/SE/DB/2023

In addition, the minimum green time for the pelican crossing is calculated, which refers to Keputusan Direktur Jenderal Perhubungan Darat Nomor SK.43/AJ 007/DRJD/97 Tentang Perekayasaan Fasilitas Pejalan Kaki Diwilayah Kotathe use of the following formula:

$$PT = L/vt + 1,7 (N/W - 1)$$

Information:

PT = Minimum green time for pelican (seconds)

L = Pedestrian speed (m/sec)

vt = Width of the section to be crossed (m)

N = Number of pedestrians crossing the cycle

W = Width of the section of road used for crossing (m)

Table 5. Distribution time pelican cycle

Period	Light For		Duration (seconds)
	Vehicle	Pedestrian	
1	Green	Red	No determined
2	Yellow	Red	
3	Red	Red	
4	Red	Green	Calculated with formula
5	Red	Flashing green	
6	Red	Red	

Source : Directorate General of Land Transportation, 1997

RESULTS AND DISCUSSION

Pedestrian Facility Service Level Analysis

Based on the existing conditions of the study area, 446.5 meters of sidewalk damage was found, characterized by uneven surfaces and open drainage channels. Furthermore, the presence of obstacles in the pedestrian path reduces the effective width of the sidewalk and hinders pedestrian movement. These conditions indicate that the quality of pedestrian facilities in the study area is still suboptimal, requiring a service level analysis to assess their performance and existing condition. As a basis for the analysis, an inventory of all available pedestrian facilities at the study area was first conducted.

Table 6 Inventory of existing pedestrian facilities

No	Street Name	Sidewalk (m)		Crossing	Location
		Right	Left		
1	Jl. Basuki Rahmat 1	1.5	1.5	Zebra Cross	Point 1 : Sukamerindu 4-way intersection
					Point 2 : 4 hour intersection
2	Jl. Basuki Rahmat 2	2	2	Zebra Cross	Point 1 : 4 hour intersection
					Point 2 : 5-way intersection
					Point 1 : 5-way intersection
3	Jl. Letjend Suprpto	2	2	Zebra Cross	Point 2 : iBox suprpto
					Point 3 : Pharmacy chemistry pharmacy
					Point 4 : Music image
					Point 5 : KFC Bengkulu
4	Jl. MT. Haryono	1.5	-	Zebra Cross	Point 1 : Jamik Mosque Intersection
5	Jl. Bali	1.5	1.5	-	-
6	Jl. Sumatera	1.5	1.5	Zebra Cross	Point 1 : Sukamerindu 4-way intersection

Based on the results of calculations of flow, speed, density and pedestrian space, the level of service (LOS) of pedestrian facilities on each road section is obtained.

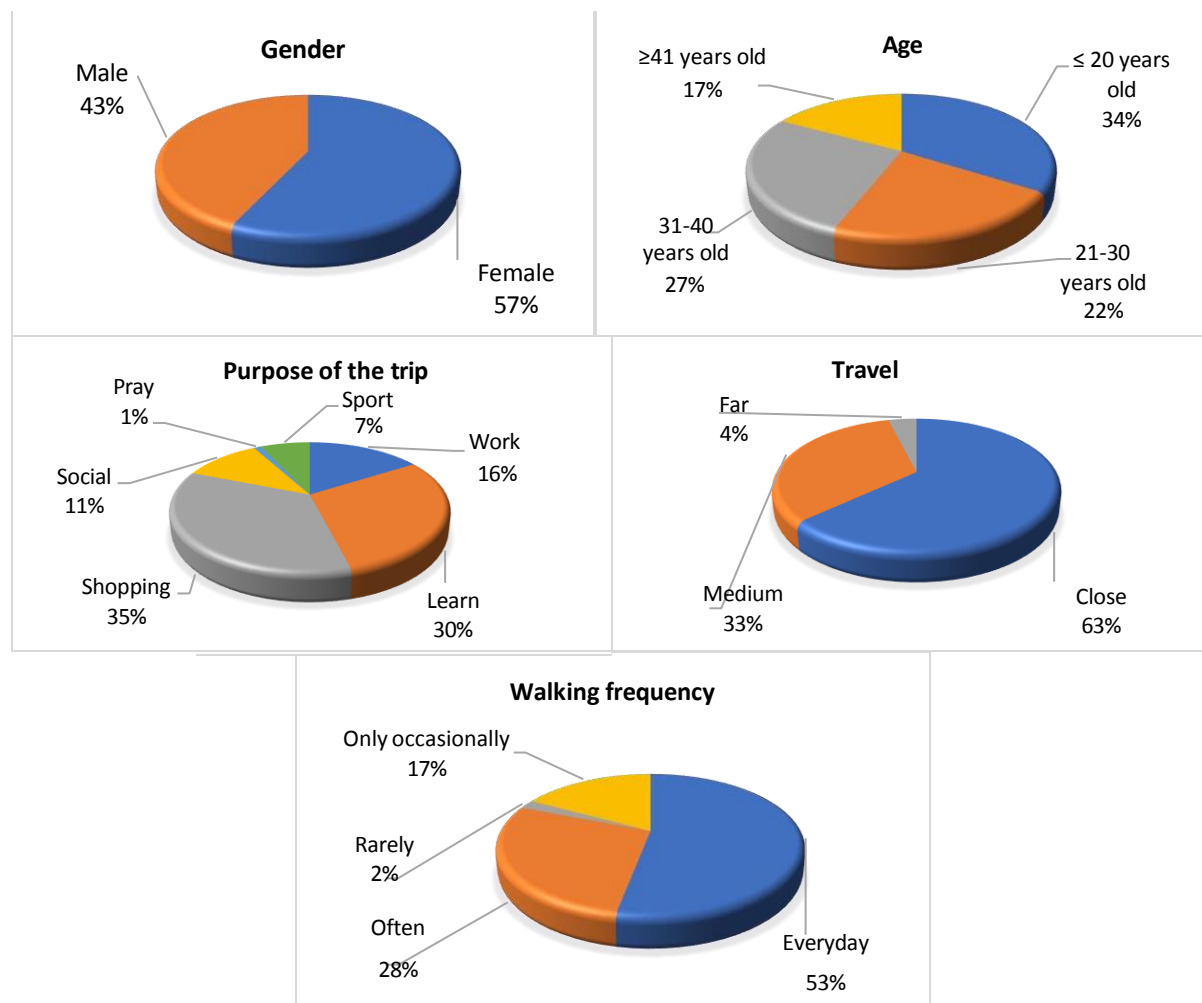
Table 7. Existing Service Level of Pedestrian Facilities

No.	Section		Pedestrian Space (m ² /Person)	Pedestrian Speed (m/min)	Pedestrian Flow (People/m/min)	LOS
1	Basuki Rahmat Street	Normal	24.16	70.87	3	A
		Opposite	0	69.99	0	F
2	Jl. Basuki Rahmat 2	Normal	8.47	70.57	8	B
		Opposite	9.91	69.39	7	B
3	Jl. Letjend Suprpto	Normal	25.50	71.39	3	A
		Opposite	49.51	72.62	1	A
4	Jl. MT. Haryono	Normal	26.40	70.40	3	A
		Opposite	0	71.40	0	F
5	Jl. Bali	Normal	0	73.94	0	F
		Opposite	0	71.21	0	F
6	Jl. Sumatera	Normal	0	69.91	0	F
		Opposite	0	70.92	0	F

Based on **Table 7**, the level of service for pedestrian facilities is still at a good level, indicated by LOS A and LOS B, indicating that the sidewalks are still comfortable to use with ample space for movement. Meanwhile, several sections received LOS F due to obstacles in the pedestrian facility path, which causes the effective sidewalk space to not be utilized optimally.

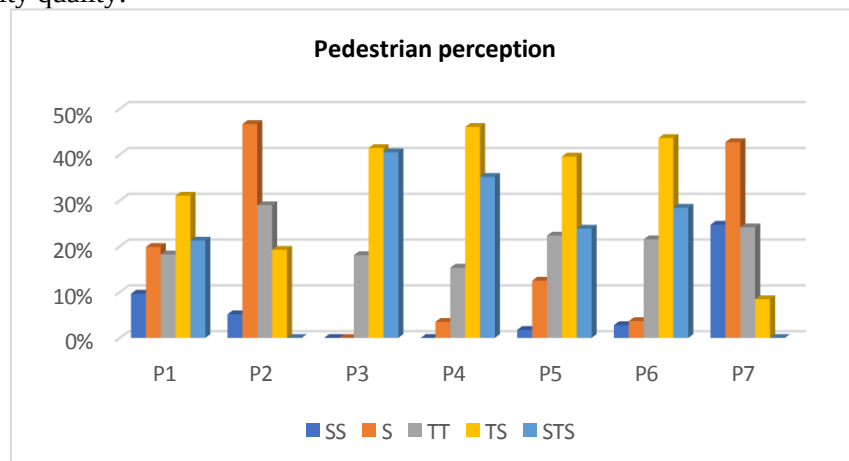
Pedestrian Characteristics and Perceptions

The characteristics of pedestrian respondents were used to determine the profile of pedestrian facility users in the study area. Based on the survey results, the majority of respondents were of productive age who commute daily for work, school, or trade and service activities.



Picture 1 Characteristics of pedestrians

The relatively high frequency of pedestrian use indicates that sidewalks and crossings play a crucial role in supporting public mobility. However, this high level of use has not been matched by adequate facility quality.



Picture 2 Pedestrian perception

The perception assessment results in **Picture 3** show that the continuity and quality of paths, as well as pedestrian conflicts, were the parameters with the lowest scores. This indicates that pedestrians still face the risk of conflict with motorized vehicles due to limited walking space and the disconnectedness of facilities. Conversely, the supporting facilities and security from crime were rated as good by pedestrians as facility users.

Walkability index (IKB) analysis

Walkability Index analysis was conducted to evaluate the level of walkability at the study location. The assessment was conducted on seven parameters based on Circular Letter No. 15/SE/DB/2023 concerning Guidelines for Determining the Walkability Index in Urban Areas.

This study consisted of six road sections, which were then divided into 20 segments to simplify the analysis process and provide a more focused assessment. Parameter weighting in this study was based on the level of influence each parameter has on walkability quality .

Table 8. Parameter weighting in walkability index

Parameter	Weight
Condition and quality of pedestrian paths	0.20
Supporting facilities (amenities)	0.10
Supporting infrastructure for pedestrians with special needs	0.10
Barrier	0.15
Availability and Condition of Crossings	0.15
Pedestrian conflicts with other modes of transportation	0.20
Security from crime	0.10

Then, the roadworthiness index was calculated for each road section as presented in Table 4 below:

Table 9. Walkability index assessment

No	Parameter	Jl. Basuki Rahmat 1	Jl. Basuki Rahmat 2	Jl. Letjend Suprpto	Jl. MT. Haryono	Jl. Bali	Jl. Sumatera
P1	Condition and quality of pedestrian paths	54.22	56.53	87.27	30.61	54.96	53.86
P2	Facility amenities	20.00	34.27	31.37	20.00	21.20	25.00
P3	Supporting infrastructure for pedestrians with special needs	10.00	10.00	10.00	10.00	10.00	10.00
P4	Barrier	26.87	19.97	35.45	35.60	22.90	26.49
P5	Availability and Conditions Crossing	35.27	40.17	60.00	28.65	15.00	22.02

No	Parameter	Jl. Basuki Rahmat 1	Jl. Basuki Rahmat 2	Jl. Letjend Suprpto	Jl. MT. Haryono	Jl. Bali	Jl. Sumatera
P6	Pedestrian conflicts with other modes of transportation	55.05	58.39	69.70	39.44	58.93	54.94
P7	Security from crime	40.00	46.69	50.00	50.00	50.00	40.00
	AVERAGE	34.49	38.00	49.11	30.61	33.29	33.19

The Walkability Index assessment results indicate that sidewalk obstructions, the availability of facilities for people with disabilities, and the availability of crossings are the aspects with the lowest scores. The presence of street vendors, business activities, and vehicle parking reduce the effective width of sidewalks, thus hindering pedestrian movement. Furthermore, limited crossing facilities and the lack of disability-friendly facilities result in suboptimal pedestrian accessibility. On the other hand, the condition and quality of pedestrian paths and the crime-prevention parameters show relatively better scores. However, these conditions are not enough to compensate for the poor quality of available pedestrian facilities.

Facility needs analysis

After conducting an analysis taking into account existing conditions, the proposed sidewalk width can be seen in the following table.

Table 10. The need for pedestrian facilities width

No	Road Section	Side	Kereb (m)	Facility line (m)	Effective width (m)	dimensions (m)
1	Jl. Basuki Rahmat 1	Left	0.15	0.5	2.35	3
		Right	0.15	0.5	2.35	3
2	Jl. Basuki Rahmat 2	Left	0.15	0.5	2.85	3.5
		Right	0.15	0.5	2.85	3.5
3	Jl. Letjend Suprpto	Left	0.15	0	1.85	2
		Right	0.15	0	1.85	2
4	Jl. MT Haryono	Left	0.05	0	1.85	1.9
		Right	0.15	0	1.85	2
5	Jl. Bali	Left	0.15	0	1.85	2
		Right	0.15	0	1.85	2
6	Jl. Sumatera	Left	0.15	0	1.85	2
		Right	0.05	0	1.85	1.9

The following are the results of the calculations for planning level crossing facilities.

Table 11. Need for pedestrian crossing facilities

No	Road Section	Average P	Average V	PV2	Recommendation
1	Jl. Basuki Rahmat 1	50	1,902	180,785,113	Pelican
2	Jl. Basuki Rahmat 2	52	2,724	385,849,152	Pelican with stall Wait
3	Jl. Letjend Suprpto	51.25	2,360	285,381,528	Pelican with stall Wait
4	Jl. MT Haryono	50.25	1,473	109,065,895	Pelican
5	Jl. Bali	54.25	1,980	212,735,411	Pelican with stall Wait
6	Jl. Sumatera	40	1,690	114,210,203	No There is

The next step is to calculate the minimum green time at the pelican crossing to determine the duration of time required for pedestrians to cross safely. Below is a diagram of the recommended Pelican cycle times.

Table 12. Pelican minimum green time

No	Road Section	Vt	L	N	W	N value	PT
1	Jl. Basuki Rahmat 1	1.2	12	18	2.5	3.6	11
2	Jl. Basuki Rahmat 2	1.2	12	19	2.5	3.8	11
3	Jl. Letjend Suprpto	1.2	14	19	2.5	3.8	13
4	Jl. MT Haryono	1.2	11	17	2.5	3.4	10
5	Jl. Bali	1.2	11	18	2.5	3.6	10

Proposed design of pedestrian facilities



Picture 3 Proposed design of pedestrian facilities

CONCLUSION

The existing condition of pedestrian facilities in Bengkulu City still faces various problems, such as damaged sidewalks along 446.5 meters and obstacles in the form of street vendors, vehicle parking, and business activities. The LOS analysis shows the best performance on Jl. Letjend Suprpto (LOS A), while Jl. Basuki Rahmat 1, Jl. MT. Haryono, Jl. Bali, and Jl. Sumatera obtained LOS F due to the lack of effective sidewalk width.

The accessibility level based on the Walkability Index (IKB) on all road sections studied is in the *Inadequate category*, with scores ranging from 30.61–49.11. The low IKB value is influenced by the high number of obstacles on the sidewalk which reduces the comfort and safety of pedestrians so that they often have to walk on the road.

Proposed improvements to pedestrian facilities include sidewalks with a minimum effective width of 1.85 meters, disabled guideways, seating, trash cans, bollards, lighting, and supporting signs. Additionally, improvements to crossing facilities are proposed, including pelican crossings and pelican crossings with waiting stalls to improve pedestrian safety and comfort.

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