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PEDESTRIAN FACILITY DESIGN FOR SPORTS CENTRE AREA IN SMALL TOWN OF INDONESIA (CASE STUDY: BIMA SPORTS CENTRE AREA)

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Pedestrian infrastructure; pedestrian facilities; PLOS evaluation CSI evaluation; infrastructure planning

ABSTRACT

The largest public space in Cirebon City, Indonesia, is Bima Sports Center, with conditions that could be more conducive, resulting in the conversion of sidewalks that are not suitable for their function into areas for street vendors and illegal parking, which hurts the interests of pedestrians. This study aims to provide design recommendations (prototype) based on PU regulation no. 02/SE/M/2018 about pedestrian facility standards. The methods used in this research are the Pedestrian Level of Service (PLOS) approach in evaluating the performance of pedestrian facilities, the Customer Satisfaction Index (CSI) approach in assessing pedestrian satisfaction, and providing design recommendations based on the results of the CSI analysis. The research results show that the PLOS value in existing conditions varies from A - to F, and the main variables that determine pedestrian satisfaction are cleanliness, safety, and lighting facilities. Based on the analysis of the results, the design recommendation is to adjust the geometry according to standards and emphasize the Provision of cleaning facilities (bins), lighting, and safety fences along pedestrian paths.

INTRODUCTION

The development of pedestrian infrastructure has become a crucial part of urban planning in cities worldwide, with growing recognition of the importance of walkability for health, environmental, and economic reasons. According to research (Ariffin, 2020), pedestrian facilities enhance mobility and promote environmental sustainability by reducing reliance on motorized transportation. However, while larger cities have made considerable progress in improving pedestrian networks, smaller towns often lag due to budget constraints, inadequate planning, and low prioritization. As seen in Indonesia, urban planning strategies usually focus on metropolitan areas, leaving smaller towns with suboptimal pedestrian infrastructures (Simarmata, 2019). This imbalance highlights the need for research on pedestrian facility design in smaller cities to bridge the gap in infrastructure development and ensure accessibility and mobility for all.

Bima, a small town in Indonesia, is an example of this disparity in infrastructure development. As the city has grown, the local government has initiated the development of sports facilities, such as the Bima Sports Centre, a vital area for promoting physical health and recreational activities. However, pedestrian access to and within this facility has been poorly developed. In a study (Wardani, 2021), inadequate pedestrian infrastructure is often cited as a barrier to the full utilization of such facilities, as users find it difficult to navigate safely to the area, leading to increased use of private vehicles even for short distances. The absence of well-designed pedestrian pathways limits the accessibility of the sports centre, especially for people with disabilities or elderly citizens (Sari, 2019). Given the importance of sports and recreation for physical and mental health, providing appropriate pedestrian infrastructure is critical for supporting public health initiatives and fostering community engagement.

Pedestrian facility design uses several theoretical frameworks to ensure safety, accessibility, and comfort. One such model is the "Five Cs" of pedestrian facility design: Convenience, Connectivity, Comfort, Coherence, and Conviviality (Barton, 2020). These principles emphasize the need for pedestrian networks to provide direct and accessible routes, offer safety and comfort, and integrate with the surrounding urban environment to encourage usage (Barton, 2020). A well-designed pedestrian facility considers factors such as pedestrian volume, traffic flow, and surrounding land use to create a seamless connection between destinations. As noted by (Li, 2022), accessibility is also a critical aspect, with Universal Design principles ensuring that pedestrian facilities accommodate individuals of all physical abilities, fostering an inclusive environment.

In the context of sports centre areas like Bima, pedestrian design should prioritize accessibility, walkability, and safety to encourage foot traffic and reduce congestion caused by vehicles. The design must integrate not only functional aspects but also aesthetic and environmental considerations, as noted by (Sudaryanto, 2021), who explored how green spaces and pedestrian pathways could be harmonized to enhance the overall experience for users. Several studies have examined pedestrian facility design in small towns and urban areas. For instance, a study (Lee, 2019) on pedestrian infrastructure in secondary Southeast Asian cities highlighted that smaller towns often need more money and expertise to develop comprehensive pedestrian networks, leading to fragmented infrastructure that discourages walking. The findings suggest that integrated planning involving local communities and urban designers is essential for ensuring pedestrian-friendly environments (Lee, 2019). Another study (Rahman, 2020) discussed how pedestrian facilities in smaller towns in Indonesia often need to be better maintained, leading to safety concerns and underutilization.

Similarly, research conducted by (Kurniawan, 2022) on pedestrian pathways in recreational areas found that facilities like sports centres are often poorly connected to other parts of town, creating an accessibility barrier. Their study highlighted the importance of strategically placing pedestrian crossings, signage, and rest areas to encourage usage, especially for elderly and disabled individuals. Furthermore, (Ade, 2021) explored how poorly designed pedestrian pathways can negatively impact public health by discouraging walking as a means of transportation and recreation. Regarding design strategies, several studies advocate for using "greenways" or dedicated pedestrian paths that incorporate natural elements like trees and water features to make walking more appealing. Research (Susanti, 2020) has shown that well-designed pedestrian facilities, especially those that provide shade and seating, significantly increase the likelihood of people walking rather than driving. This is particularly relevant for sports centres, where users are already inclined toward physical activity, and a pleasant walking environment can further promote health and fitness.

The increasing importance of promoting physical activity, especially in small towns like Bima, underscores the urgency of developing better pedestrian infrastructure. According to the (WHO, 2018), insufficient physical activity is a global health risk, and creating supportive environments for walking can mitigate this risk. As sports centres like Bima Sports Centre play a critical role in community health, ensuring safe and accessible pedestrian pathways is essential for maximizing their use and effectiveness. This research addresses a significant gap in the literature by focusing specifically on pedestrian infrastructure in sports centre areas in small towns. This topic has received limited attention in previous studies. While many studies have examined urban pedestrian infrastructure, few have examined how smaller cities can implement these designs to improve public health and accessibility (Susilo, 2019). This study will explore specific design interventions tailored to the unique needs of small-town sports centres, contributing to a more comprehensive understanding of pedestrian infrastructure development in such settings. The primary objective of this research is to design a pedestrian facility that ensures accessibility, safety, and comfort for users of the Bima Sports Centre. Specifically, the study aims to Assess the current state of pedestrian infrastructure in the Bima Sports Centre area and identify existing barriers to accessibility, Develop a design proposal for pedestrian pathways that adhere to the principles of convenience, connectivity, comfort, and safety, Explore how pedestrian facilities can integrate environmental elements to enhance user experience and promote walking as a mode of transportation and recreation, Provide recommendations to local government and planners on how to implement and maintain pedestrian facilities in small towns, ensuring long-term usability and sustainability(Setiawan, 2022).

The design of pedestrian facilities for sports centres in small towns like Bima is a pressing issue that directly impacts public health, safety, and accessibility. While many larger cities in Indonesia have made strides in developing walkable environments, smaller towns often need more resources and adequate planning. This research seeks to address this gap by providing a comprehensive design proposal for pedestrian infrastructure in the Bima Sports Centre area, drawing upon established principles of pedestrian facility design and integrating findings from previous studies. Doing so aims to contribute to the broader conversation on urban planning and public health in small towns, offering practical solutions that can be implemented across Indonesia.

RESEARCH METHOD

Research Location

The research site is in the Bima sports area of Cirebon City, Indonesia. The research location point is divided into 4 (four) segments and six path types, with 17 pieces divided into the research area. The kinds of pedestrian paths at the study location are as follows:

1. Type 1 : (Separated) Sidewalk is found in segment 1A-1F and segment 2A-2C
2. Type 2 : (Separated) Boulevard is on segment 1
3. Type 3 : (Car Dominant) Pedestrian ways use public roads, but vehicles are more dominant as in segments 3A, 3B
4. Type 4 : (Integration) Pedestrian ways using public roads are found in segment 3C, 3D
5. Type 5 : (Path) types used by pedestrians, bicycles, runners and joggers. It is not intended for pedestrians only in segments 4A-4D.

6. Type 6 : (Corridor) Covers corridors, connecting roads between pedestrian paths. Vehicles are prohibited from passing through this lane, as found in segment 3.

Figure 1. Research Location Delineation Maps

Research Approach Method

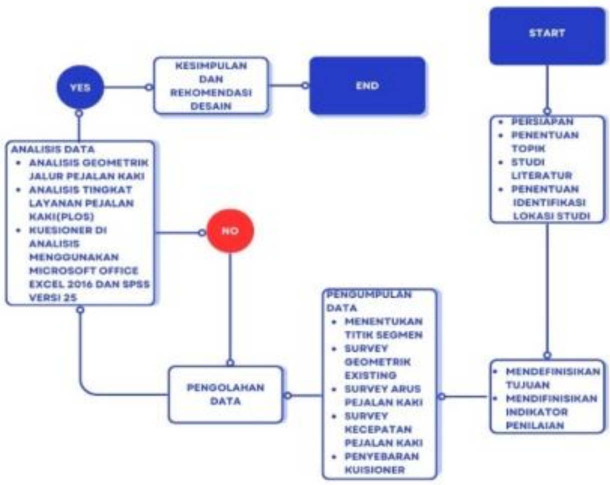


Figure 2. Research flow

In this study, various surveys were conducted with a quantitative approach in the form of primary data collection, which can be divided into several study activities ranging from preparation, setting objectives and assessment indicators, data collection, and data analysis to making technical recommendations based on the study results. This study's primary surveys were determining segment points, pedestrian flow surveys, pedestrian speed surveys, and volume surveys with geometric measurements such as effective width, section length, and questionnaire distribution. The results of the primary study were then processed and analyzed to produce Pedestrian Level of Service (PLOS) values, which represent the performance of pedestrian services at the study site. Subsequently, design recommendations were planned based on the study results to improve pedestrian service performance.

Data Collection Technique

In this study, primary data collection was carried out with a quantitative approach taken directly in the field for 7 (Seven) days in several stages. The first stage was a survey of existing Geometrics and completeness of pedestrian safety facilities, such as disability guide lanes, bus stops, seats, lighting, and toilets. Existing geometric data taken includes information such as the existence of sidewalk conditions, sidewalk width, sidewalk length, sidewalk elevation height, sidewalk structure, and land use taken at 17 points of the research segment using a pull meter where this survey was carried out for 2 (Two) days and the results were recorded in the survey form. The data obtained is used to determine the needs and planning of sidewalks by technical standards, and it is later processed and analyzed to produce pedestrian level of service (PLOS) values. Furthermore, primary data collection of pedestrian flow and pedestrian speed surveys was carried out at 2 (Two) peak times, namely afternoon and evening. The afternoon survey was conducted from 12:00-1:00 pm, while the afternoon survey was conducted from 3:00-4:00 pm for two consecutive days. The first step is taking pedestrian flow survey data.

The questionnaire was designed to understand the level of pedestrian perceptions of safety and comfort when walking on sidewalks. In the questionnaire survey, pedestrians were asked to rate their overall satisfaction with the sidewalk facility and the importance of it. In each question of the questionnaire, respondents were asked to rate the impact of a particular attribute on their intentions on a Likert scale of 1 to 5, ranging from 1 (strongly disagree), 2 (disagree), 3 (undecided), 4 (agree), 5 (strongly agree). Respondents consisted of 100 people who potentially use pedestrian paths. Determination of the number of sample respondents was taken by the Slovin method from a population of 341,980 Cirebon City residents with a tolerance level of 10% error with a data accuracy level of 90% using the formula:

n = N/ (1+ N. e2)

Where: n = sample

N = Total Population

e = fault tolerance

Sample Calculation:

N = 341.980

e = 10%

n = 341.980 /(1+(341.980 x (10%)^2)

= 99,587999 rounded up to 100 respondents

Based on this calculation, we get a population of 100 respondents.

Analisis Tingkat Pelayanan Pejalan Kaki (PLOS)

This study used PLOS (pedestrian level of service) values. Using the PLOS value, decision-makers and urban planners can identify areas that need improvement to improve pedestrian safety, comfort, and convenience (Asadi-Shekari et al., 2013), (Nag et al., 2020). This value can also help prioritize investments and allocate resources more as a sustainable mode of transportation (Nag et al., 2020). Calculating the pedestrian level of service using the PLOS measurement technique will get a grade with a scale from A to F, presenting the results. "A" indicates "very satisfactory conditions", while "F" reflects "no movement" or "very unsatisfactory conditions", as also regulated by the Minister of Works Regulation. The PLOS pedestrian parameter levels for the calculation can be seen in Table 1 below:

Table 1. Site Selection Based on Road Hierarchy

Service Level	Space (m2/p)	Flow Rate (p/min/m)	Velocity (m/sec)	V/C
A	>5.6	≤16	>1.30	≤0.21
B	>3.7 - 5.6	>16 - 23	>1.27 - 1.30	>0.21 - 0.31
C	>2.2 - 3.7	>23 - 33	>1.22 - 1.27	>0.31 - 0.44
D	>1.4 - 2.2	>33 - 49	>1.14 - 1.22	>0.44 - 0.65
E	>0.75 - 1.4	>49 - 75	>0.75 - 1.14	>0.65 - 1.00
F	≤0.75	variable	≤0.75	variable

Analysis of the CSI (Customer et al.) Method

CSI (Customer et al.) is used to process questionnaire data in this study. The scale used is Likert 1 to 5, Likert Scale, used to show the level of agreement and disagreement of the community with each variable as shown in the table below:

Table 2
Questionnaire Question Variables

Variable	Variable Name	Variable	Variable Name
V1	Street Vendor Arrangement	**V11**	Provision of safe passage for people with disabilities
V2	Parking arrangements on the street	**V12**	Provision of public street lights/lighting
V3	Maintenance of cleanliness	**V13**	Provision of public toilets
V4	Noise/noise pollution control	**V14**	Parking lot provision
V5	Pathway capacity control	**V15**	Provision of pots/attributes
V6	Pathway surface quality improvement	**V16**	Provision of safety elements
V7	Provision of trash bin facilities	**V17**	Zebra Crossing Provision
V8	Provision of transportation shelters	**V18**	Pathway damage maintenance
V9	Seating provision	**V19**	Improved pedestrian area safety
V10	Provision of shade	**V20**	Provision of guard posts

RESULTS AND DISCUSSION

Pedestrian Path Geometric Analysis

The figures below show the results of the geometric data collection of pedestrian paths in the study area, divided into segments and sections. The geometric data considered are the pedestrian path, the length of the pedestrian path, and the effective width of the pedestrian path. Existing Geometrics can be seen in the figure below:

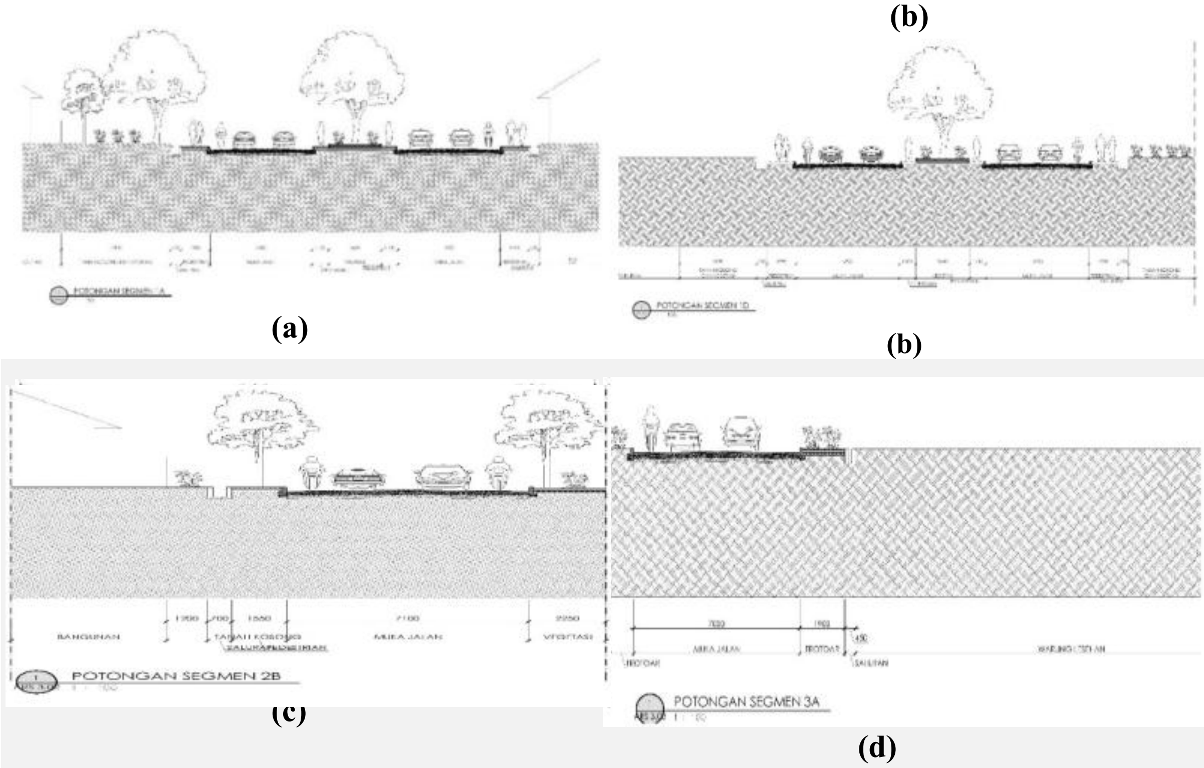
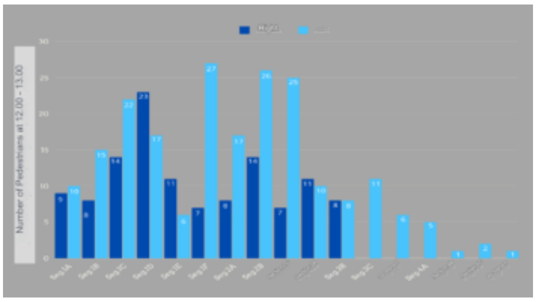


Figure 3. Existing Geometric Condition

Based on the results of geometric analysis that refers to PU standard no. 02 / SE / M / 2018, it can be concluded that there are still pedestrian paths that do not meet the standards, such as images (a) and (b), which have a sufficient width with a width of 1.8 meters but unfit pavement surface conditions. Image (c) has a pedestrian width that does not meet the standard with a width of 1.55 meters and a pedestrian path mixed with vegetation lanes, while image (d) has no pedestrian path at the research location.

Pedestrian Walkway Performance Analysis.

Figures 4 and 5 show the pedestrian flow values at the study site in the afternoon and evening peak hours. The survey results show that the highest pedestrian flows are found in Segment 1 section D in the afternoon peak hour and Segment 4 section B in the afternoon peak hour. Segment 1 is a place of sports and culinary activities, so the flow of pedestrians in Segment 1 is dominated by students and workers busy during the day. Segment 4 is a jogging track area, so the flow of pedestrians is dominated by people who exercise.



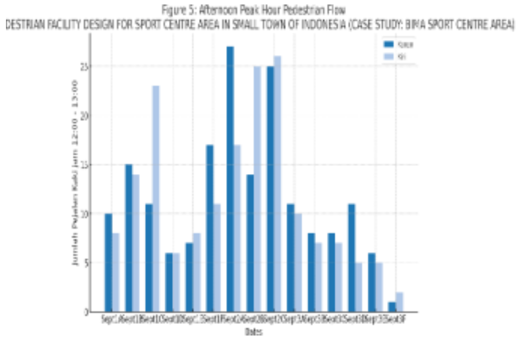
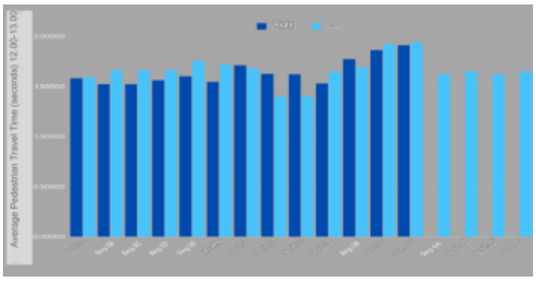


Figure 4. Daytime peak hour pedestrian Flow **Figure 5. Afternoon peak hour pedestrian flow**

Figures 6 and 7 show the average value of travel time during the day and evening. Based on the survey results, the average travel time of pedestrians in the study area ranges from 1.4 to 1.9 minutes per 100 meters. This difference is due to differences in walking speed, which are influenced by age, gender, interest in walking, and the condition of walking facilities.



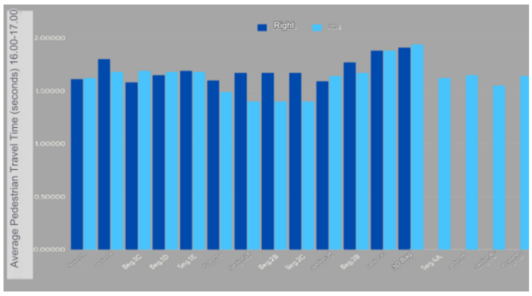


Figure 6. Average daytime peak hour pedestrian travel time **Figure 7. Average daytime peak hour pedestrian travel time**

PLOS scores can be based on available pedestrian space, flow, speed, or V/C ratio. In this study, the PLOS value is based on the availability of available walking space from the primary survey. Referring to the 1985 Highway Capacity Manual (HCM), the results of the primary survey, and the analysis conducted, most of the study sites have a PLOS A value in terms of free space, which means that pedestrians can move in the desired pedestrian space without changing their movement due to the influence of other pedestrians and are free to choose their walking speed. Some sections have PLOS scores of B and C, meaning the pavement condition can still function optimally for pedestrian services. Some sections have a PLOS D value where pedestrian walking speed must be limited due to interaction or conflict with other pedestrians. The worst condition in the study area is PLOS E, which means it is very difficult for pedestrians to get ahead of other pedestrians because the number of pedestrians has reached the limit of pedestrian space due to free walking areas.

Figure 8. Distribution of Sites with Low PLOS Score

Figure 8 shows the distribution of areas with low PLOS values in the study area. The sections with low PLOS include the pedestrian path in section 1D and sections 3A, 3B, 3C, and 3D. After comparing the geometric conditions of the pedestrian paths, low PLOS values were obtained for the following reasons:

1. The walkway is not accessible from one or both sides
2. The walkway is blocked by illegal parking
3. The research location is in an area with many culinary and sports for pedestrians.

Therefore, a policy prohibiting car parking for pedestrians can be issued as a technical recommendation to overcome the study site's low PLOS value. To reduce side obstacles and increase the effective width of the footpath, the footpath should be widened at least to the applicable standard.

User Satisfaction Level using the CSI Method

Based on the promenade's design from the road users' perspective, 20 variables were tested as design factors. The variables were then ranked in a questionnaire with a Linkert scale of 1-5, where the higher the point, the better the street users' view of walkability compared to the measured factor. The questionnaire was tested on 100 respondents. The questionnaire items were tested by analyzing using SPSS version 20. They obtained a count value greater than the table, where the df value is 100-2 = 98, and the significance is 0.05, so the table value is 0.1654. From the results of the validity calculation, obtained r count> r table, 100 questionnaires are declared valid because the r count is more than the r table. The reliability test results on the question variable can be seen from the table below that Cronbach's alpha on this variable is higher than 0.60, where this figure is the basic value, and it can be concluded that all statements on this variable are declared reliable or trustworthy. Based on the CSI (Customer et al.) calculation results in Table 4, we get a CSI value of 37%. This shows that the level of satisfaction based on the interests of the Cirebon city community towards pedestrian facilities in the study area is still low. The low level of community satisfaction is based on Table 3, which shows that the CSI value obtained in this study is in the range of $X \leq 64\%$, which means that it shows that the people of Cirebon City are very dissatisfied with pedestrian facilities in existing conditions at the research location.

Table 3. Customer Satisfaction Index Interpretation

ANGKA INDEX	INTERPRETATION
$X \leq 64\%$	Very Poor
$64 < X \leq 71\%$	Poor
$71 < X \leq 77\%$	Cause for Concern
$77 < X \leq 80\%$	Borderline
$80 < X \leq 84\%$	Good
$84 < X \leq 87\%$	Very Good
$87\% < X$	Excellent

Description: X: Customer satisfaction index number Source: Customer Satisfaction Measurement, www.leadershipfactor.com.

Table 4. Service quality CSI value

Attribute	MISI value	MSSi value	Wfi value	WSi value	CSI value
1	4.26	1.98	4.90%	10%	37%
2	4.26	1.79	4.90%	9%	
3	4.26	1.77	4.90%	9%	
4	4.26	2.07	4.90%	10%	
5	4.27	2.17	4.92%	11%	
6	4.55	2.02	5.24%	11%	
7	4.45	1.78	5.12%	9%	
8	4.18	1.86	4.81%	9%	
9	4.3	1.73	4.95%	9%	
10	4.37	2.18	5.03%	11%	
11	4.35	1.78	5.01%	9%	
12	4.52	1.85	5.20%	10%	
13	4.4	1.75	5.07%	9%	
14	4.4	1.84	5.07%	9%	
15	4.14	1.82	4.77%	9%	
16	4.33	1.74	4.98%	9%	
17	4.36	1.72	5.02%	9%	
18	4.43	1.72	5.10%	9%	
19	4.44	1.79	5.11%	9%	
20	4.34	1.66	5.00%	8%	
TOTAL	86.87		100%	185%	

Based on the low level of satisfaction with pedestrian facilities in the study area, we can see the variables that greatly influence respondents' satisfaction. The analysis shows that respondents are very dissatisfied with V3 (Maintenance of cleanliness), V12 (Provision of public street lights and lighting), and V19 (improvement of pedestrian area security).

Table 5. Satisfaction Questionnaire Results

Variable	Number of Parameters of Importance (%)					Variable	Number of Satisfaction Parameters (%)				
	1	2	3	4	5		1	2	3	4	5
V3	48%	18%	12%	1%	1%	V3	0%	0%	14%	25%	61%
V12	37%	26%	11%	1%	0%						
						V19	0%	0%	10%	36%	54%

Design Recommendations

Based on the results of the CSI analysis, the design recommendations emphasize the Provision of cleaning, security, and lighting facilities. In addition, in locations with less than the standard width, it is recommended that facilities be widened and provided according to PU standard No.03/PRT/M/2014.

Before **After**

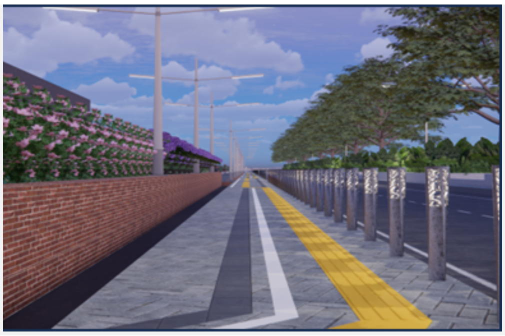


Figure 9. Existing Condition Segment 1 A **Figure 10. Prototype Design Segment 1 A**

The research results found that segment 1A already has a good PLOS value, namely A, but several elements, such as the design recommendations in Figure 10, need to be improved, such as the disability path, safety fence, and lighting.

Before **After**

Figure 11. Existing Condition Segment 1 D **Figure 12. 1 D Segment Design Prototype**

The research results obtained in segment 1D have a good PLOS value, namely B. Still, several elements need to be improved on the disability path and safety fences, as shown in Figure 12.

Before **After**

Figure 13. Existing Condition Segment 2 B **Figure 14. Prototype Design Segment 2 B**

The research results obtained in segment 2B have a problem with the pedestrian path where the vegetation area is combined with the pedestrian path, as shown in Figure 13. This results in the low PLOS value in this segment, namely C. Therefore, as shown in Figure 14, this study recommends a redesign by separating the pedestrian and vegetation paths, increasing the PLOS value in this segment.

Before **After**

Figure 15. Existing Condition Segment 3A

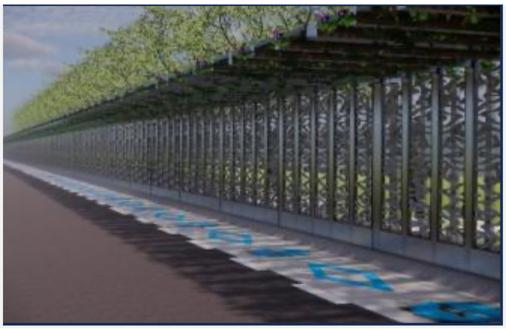
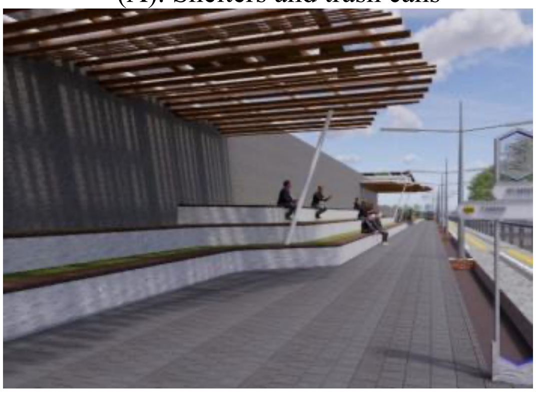


Figure 16. Prototype Desain Segmen 3A

Figure 17 shows the recommendations for facilities emphasized in the design based on pedestrian perceptions of the importance of cleanliness, security, and lighting.

(A). Shelters and trash cans

(B). Safety Fence



(C). Seating

(D). Lighting Lamp

Figure 17. Facilities emphasized in the design based on Pedestrian perception

CONCLUSION

Based on the results of the analysis, it can be concluded that with the existing geometric conditions of the research area, there are still several segments that do not have pedestrian paths and green lanes that are mixed with pedestrian paths plus the PLOS value shows the results of D to F in several segments that have pedestrian paths with a low level of service, with the results of CSI interests contained in the variable Improving the quality of the pathway surface (V6) and the variable Provision of public street lights/lighting (V12). Then, the satisfaction table shows the highest results in parameter 1 (very dissatisfied), which is found in the variable Maintenance of cleanliness (V3), which means that in the currently existing conditions, the lack of cleanliness factors and the lack of trash can facilities in the Bima sports area. These results recommend a prototype design for the bima sports area with the concept of a cultural approach to Region 3 of West Java Cirebon, Indramayu, Majalengka, and Kuningan (CIAYU MAJAKUNING) so that the pedestrian design in the Cirebon sports area is strongly influenced by amenity factors related to cleanliness, safety of pedestrian paths, quality of pathway pavement. Thus, pedestrian path planning must translate standards and guidelines and emphasize pedestrian perspective factors to accommodate pedestrian needs and increase willingness to walk. Thus, pedestrian path planning criteria are specific to each location. However, further research is needed regarding determining subjective criteria in designing pedestrian paths.

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