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Bridging The Gap: A Comprehensive Examination of Sidewalk Utilization Challenges in Campus Environment

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ABSTRACT: *The sidewalks at Politeknik Negeri Pontianak appear to be physically adequate ; however, preliminary observations indicate that many pedestrians are reluctant to use them. This study aims to comprehensively evaluate the utilization and comfort of pedestrian sidewalks within the Politeknik Negeri Pontianak campus environment. Using a quantitative approach, the research utilizes Likert scale questionnaires and linear regression analysis through the SPSS application to examine the relationship between the physical quality and user behavior on the sidewalks. The study findings reveal that although the campus sidewalks generally meet the standard width requirements, they lack comfort features such as shading and sidewalk integration. This research emphasizes the need to prioritize comfort and shading facilities in the planning and design of sidewalks to encourage pedestrian way usage.*
KEYWORDS *sidewalks quality assessment,campusenvironment,pedestriancomfort,sidewalkutilization*

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I. INTRODUCTION

Pedestrian pathways on a campus play a pivotal role in shaping the overall campus environment and have multifaceted importance that extends beyond mere convenience. Sidewalks are crucial to support safe and comfortable walking. Their role extends beyond providing a sense of safety for pedestrians [1], especially in high-traffic areas. Shaded and integrated sidewalks can further enhance the walkability of an area (Prasetya et al., 2020). These pathways are the arteries of mobility, facilitating the movement of students, faculty, and staff across the campus. The well-designed and properly maintained pedestrian infrastructure not only ensures safe and efficient passage but also contributes to the aesthetic appeal and the quality of life on campus (Zhang et al., 2023;Hipp et al., 2016). As students and faculty walk along these pathways, they not only traverse the physical landscape of the institution but also engage in intellectual and social interactions that are fundamental to the campus experience [5]. The pedestrian way becomes more than just a physical structure; it becomes a vital element of the campus culture, fostering collaboration, dialogue, and a sense of community among its users. Moreover, prioritizing pedestrian safety is paramount. Utilizing sidewalks is crucial for several reasons, addressing safety concerns in high-traffic areas without sidewalks and potential disruptions to traffic flow [6]. Pedestrians tend to move to a more comfortable place if they do not feel safe on a particular sidewalk [7]. However, considering the good quality of the preliminary observed sidewalks, this reason may not apply to the case at the Politeknik Negeri Pontianak (Polnep) campus.

The significance of pedestrian pathways extends to the domain of sustainability, promoting the use of eco-friendly modes of mobility, reducing the reliance on conventional, fossil fuel-powered vehicles [8]. In the

Figure 1. Observation on Case Study in Politeknik Negeri Pontianak

context of the Polnep campus environment, the existence of pedestrian sidewalks is intended to prevent bottleneck situations, especially since the campus roads are narrow. However, observations near the campus revealed underutilization of these sidewalks during peak hours. Despite the sidewalks being renovated to meet standards, Figure 1 shows that almost all pedestrians during break times choose not to use them. This behavior results in congestion on the campus roads, negatively impacting the environment. Traffic congestions not only waste fossil fuels used by vehicles but also contribute to increased carbon dioxide and temperature in specific areas, potentially leading to the Urban Heat Island (UHI) effect [9]. Additionally, the congestion produces carbon dioxide, polluting the air within the campus area [10].

This raises the question: what obstacles deter pedestrians in Polnep campus from using sidewalks during peak hours? This paper aims to comprehensively evaluate the physical condition of pedestrian sidewalks in Polnep aligning the result with national standard and study the pedestrians' behaviors to identify the problems. The evaluation results can be utilized as input for policymakers to take necessary actions to encourage pedestrians to use sidewalks as they should. This involves not only regulations but also the provision of supporting facilities so that pedestrians in the campus environment can use sidewalks optimally.

II. LITERATURE REVIEW

Several studies on sidewalk usage and pedestrian comfort highlight key factors across diverse locations. In Yogyakarta's Malioboro area, pedestrians focus on information, public facilities, street vendor-related amenities, comfort, safety facilities, and the allure of street vendors [11]. A University of Indonesia campus study explored the impact of porous paving block materials on pedestrian comfort, revealing that such installations did not enhance comfort and posed risks due to water pooling after rain [12]. In Padang, sidewalk misuse for motor vehicle parking and street vendor occupation contributed to discomfort. Sidewalk users anticipated improvements in shading, regulation of misuse, and enhanced facility completeness [13]. Research on Ahmad Yani Street in Kota Payakumbuh identified factors like accessibility, aesthetics, sidewalk material condition, sanitation, and surface obstructions as significant contributors to sidewalk comfort [14]. A study in the Pasarwajo subdistrict market area found low comfort levels due to non-compliance with width standards, sidewalk conversion for street vendors, motor vehicle parking, and household activities [15]. Another study in Pangkalan Bun identified a decline in sidewalk quality concerning functionality, safety, cleanliness, accessibility, and aesthetics [16].

From the literature review of previous studies on sidewalk comfort, it can be concluded that many sidewalks are uncomfortable for use due to the lack of physical quality and the absence of facilities that support pedestrian needs. Additionally, the misuse of sidewalks disrupts pedestrian activities.

The majority of sidewalks in Indonesia do not meet the minimum requirements, such as shown on the previous studies [11][12][13][14][15][16]. Moreover, due to the warm and humid climate, few individuals opt to walk on sidewalks, preferring private transportation instead [17]. In Pontianak, the focus of this study, the lowest recorded temperature is 27ºC, while the highest is 37,1ºC, particularly in March to September. ***Table 1***displays the temperature range in Pontianak. Additionally, not only is the temperature notably high, but the precipitation percentage is also significant. **Table 2** illustrates the rainfall in Pontianak.

Table 1. Average Temperature in Pontianak from 2018 to 2020

Month	Minimum AverageTemperature (2018~2020)	MaximumAverageTemperature (2018~2020)	OverallAverageTemperature (2018~2020)
January	27.0°C	34.1°C	27.1°C
February	27.2°C	34.0°C	27.3°C
March	27.7°C	35.7°C	28.2°C
April	28.0°C	36.4°C	28.1°C
May	28.3°C	37.1°C	28.3°C
June	28.0°C	37.0°C	27.6°C
July	28.8°C	35.6°C	28.3°C
August	28.9°C	36.6°C	28.1°C
September	27.8°C	35.8°C	27.4°C
October	27.0°C	34.3°C	27.2°C
November	27.1°C	35.1°C	27.1°C
December	26.8°C	34.2°C	27.0°C

Table 2. Percipitation in Pontianak (year 2017 to 2019)

Month	2017	2018	2019
January	144.2	402	201.8
February	278.7	105	302.2
March	340.4	231	83.7
April	110.9	346	299.9
May	327.8	552.8	276.8
June	226.3	400	506.3
July	315.2	51	227.6
August	514.5	73	73
September	200.7	257	58.1
October	143.1	517.4	579.4
November	234.3	429.8	371.5
December	243.5	449	635.8

III. RESEARCH METHODOLOGY

The research utilizes a quantitative research approach. Figure 2 shows the research flows conduct in this paper. The research process begins with problem identification through initial observations, leading to the formulation of research objectives which are to evaluate the physical condition of pedestrian sidewalks and to identify the problems stated in research background. Following this, a thorough literature study is undertaken to

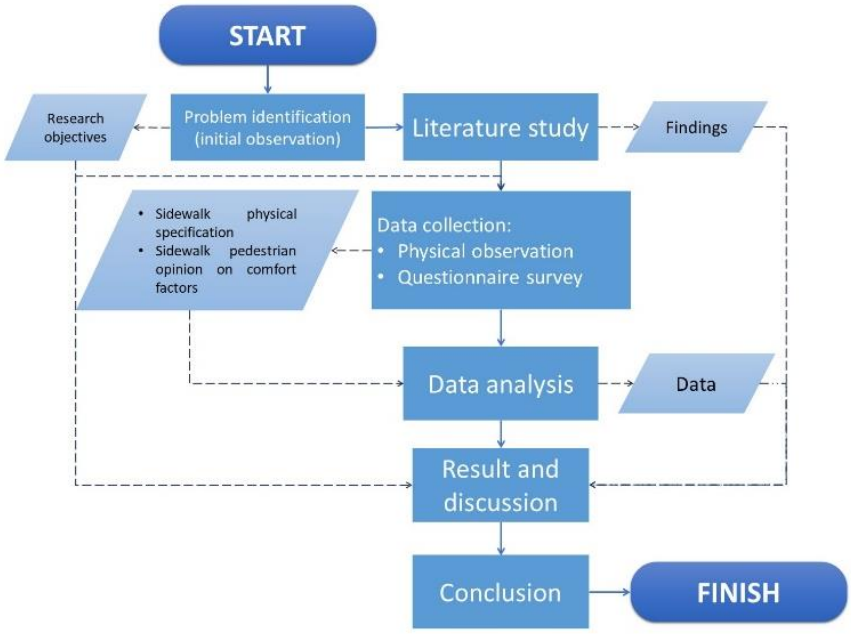

Figure 2. Research Flow

gather insights from previous studies and their findings.

The data collection phase is then conducted based on the established research objectives, employing observation methods such as sidewalk measurements (height, width, ground cover material observation) and questionnaire surveys to derive sidewalk physical specifications and evaluate pedestrian comfort. The survey is conducted by utilizing Google Form which distributed amongst the colleagues in Polnep. This paper uses random sampling method to distribute the questionnaire and utilizes Lemeshow[18] to decide the number of samples taken (equation 1). Based on the calculation using Lemeshow equation, minimum required for sample is 95 samples.

$$n = \frac{Z\alpha^2 \times (p \times q)}{d^2} \qquad (1)$$

Where Z represents the Z-statistic at a 95% confidence level (Z = 1.96); p is the estimated proportion derived from prior research; q is the complement of p (q = 1 – p); and d is the standard deviation. Questionnaires are distributed to pedestrian samples over five days (Monday to Friday) for one week. For the physical data pertaining to the sidewalks will be compared against the standards outlined by the Ministry of Public Works and Public Housing (PUPR). Sidewalk facilities are designed and provided in accordance with these specific standards. The PUPR documentation [19] on pedestrian pathway standardization provides insight into the ideal dimensions of a sidewalk, which can be calculated by solving equation (2). Adherence to these standards is crucial for sidewalk planners, as the established dimensions have the potential to significantly enhance pedestrian comfort.

$$W = \frac{V}{35} + N \qquad (2)$$

Where W is the minimum effective width of the sidewalk (meters), V is planned volume of pedestrians/two-way (people/meter/minute), and N is additional width according to local conditions (meters), as determined in Table 3.

Table 3. Additional width according to local conditions [19]

N (meter)	Situation
1.5	In areas with high pedestrian traffic (33 people/minute/meter, such as markets or terminals)
1.0	In areas with moderate pedestrian traffic (16-33 people/minute/meter, such as shopping areas other than markets
0.5	In areas with low pedestrian traffic (<16 people/minute/meter, or other areas)

Subsequently, the collected data undergoes analysis, generating valuable information. Pedestrians' opinions about the quality of the sidewalks are evaluated using Likert scale. The results obtained in conjunction with insights from previous studies and aligned with the research objectives, form the basis for the result and discussion section.

Here, the findings are interpreted in graphs that are generated using Microsoft Excel and discussed in detail using quantitative descriptive analysis method. To ascertain the correlation between the quality of both the physical and non-physical aspects of pedestrian sidewalks and the volume of pedestrian usage, this study employed regression analysis through the SPSS application. In this analysis, the independent variables (X) encompassed the evaluations of both the physical and non-physical attributes of pedestrian sidewalks, while the dependent variable (Y) was represented by the frequency of pedestrian sidewalk utilization.

The research concludes with a comprehensive summary in the conclusion section, summarizing the key findings and their implications. As the final step, the research is officially completed, marking the end of the study.

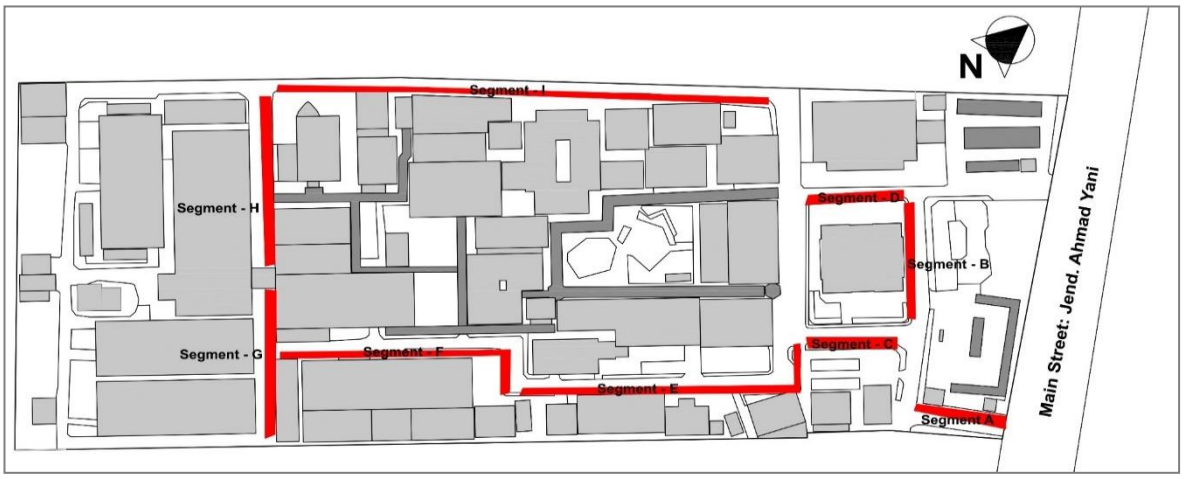

Figure 3. Campus Sidewalk Masterplan

IV. RESULT AND DISCUSSION

This paper aims to thoroughly evaluate the physical condition of the sidewalk in Polnep campus environment and the relevance with the pedestrians' behaviors. A total of 241 responses were collected, but after cross-checking, 38 inconsistent responses were deemed invalid. Therefore, the analysis was based on 203 valid responses.

The study commenced with an observation of the sidewalks within the Polnep campus. The observation technique involved measuring the width, height, length, and connectivity of the sidewalks, as well as observing the type of materials used. Figure 3 illustrates the segmentation of the sidewalks and Table 3shows the measurement compliance according to PUPR standardization [19].

Figure 4. Sidewalk segment E (above) and F (bottom) in Polnep campus shows no shading system applied

Table 4. Sidewalk standard compliance

Segment	Measurement (m) ($l \times w \times h$)	Standard compliance	User percentage
A	87 × 2,2 × 0,25	Yes	2,7%
B	92 × 2,2 × 0,25	Yes	2,9%
C	40 × 2,2 × 0,25	Yes	8%
D	81 × 2 × 0,25	Yes	3,3%
E	164 × 1,6 × 0,2	Yes	22,9%
F	44 × 1,6 × 0,2	Yes	24,5%
G	34 × 1,2 × 0,6	No	12,8%
H	61 × 1,2 × 0,6	No	15,3%
I	170 × 1,6 × 0,15	Yes	3,9%

In the**Table 4**, *l* stands for length; *w* stands for width, while *h* stands for height of the sidewalks. Through observations, it was found that generally the sidewalk segmentation adheres to the minimum width requirement of 1.5 meters, as stipulated by PUPR guidelines. Nonetheless, in certain sidewalk segments, the sidewalk height measured between 30 – 60 cm, surpassing the standard of 15 cm. Moreover, the survey uncovered the lack of shading facilities on all of the sidewalks in Polnep campus (see **Error! Reference source not found.**).

In terms of the number of users, the sidewalks in segment E and F have the highest user percentage. Walking activities are primarily associated with the need to go to other buildings (42.8%), to worship in the mosque (28.2%), to go to parking areas (23.2%), and to purchase food (5.3%).Table 5presents the information of the valid respondents (203 data). Overall, the majority of sidewalk users were students (with 390 pedestrians aged 18 to 25), and the majority of pedestrians were male (301 pedestrians).

For the analysis of walking frequency and sidewalk usage, data from non-sidewalk users were excluded, leaving 467 datasets for analysis. From the 467 datasets resulting from the survey, it was observed that 80% of people frequently walk more than 20 meters in the Polnep campus area while the remaining 20% showed that overall sidewalk users rarely walked more than 20 meters. Users' experience evaluation reveals that 57% of people frequently used sidewalks, while 43% stated that they rarely used sidewalks because (a) they felt uncomfortable using them, (b) the sidewalks did not assist walking activities, and (c) there were numerous disturbances or obstacles. The discomfort mentioned was associated with experiences of using the sidewalk under the sun or rain without adequate shading on the existing sidewalks. Figure 5 shows the composition of this finding.

The results of this analysis lead to the answers to the research questions. First, although 80% or 374 pedestrians admitted to frequently walking more than 20 meters, only 57% or 265 pedestrians reported using sidewalks frequently. This indicates that even though pedestrians on the Polnep campus engage in walking activities of more than 20 meters, not everyone uses the sidewalks. The difference between pedestrian data and sidewalk users is 118 people.

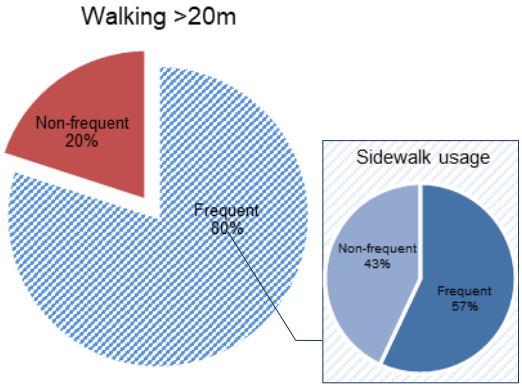

Figure 5. Composition of sidewalk users amongst pedestrians in Polnep campus

Regarding the survey results for all sidewalk segments regarding the reasons for infrequent use of sidewalks, it was found that 50% or 100 pedestrians who walked more than 20 meters on the Polnep campus felt uncomfortable and thus avoided using the sidewalks. 26% or 53 pedestrians felt that sidewalks did not assist in walking activities, while 24% or 49 individuals stated that they encountered many disturbances or obstacles on the sidewalks.

Table 5. Users based on categorization in each sidewalk segment

Categories	Segmentation									Non user	Total
	A	B	C	D	E	F	G	H	I		
Age (years)											
18-20	4	4	12	5	40	56	24	33	6	4	188
21-25	4	5	16	8	39	41	26	32	10	1	182
26-35	0	0	2	0	5	8	3	2	1	3	24
36-50	5	3	4	1	15	9	6	4	1	5	53
>50	0	2	5	2	12	5	3	2	1	5	37
Gender											
Male	8	6	23	9	80	75	37	43	13	7	301
Female	5	8	16	7	31	44	25	30	6	11	183
Occupancy											
Students	8	9	28	13	80	98	51	65	16	5	373
Lecturers	3	4	8	2	23	17	9	7	2	11	86
Officials	1	0	1	1	3	1	1	0	1	1	10
Technicians	0	1	1	0	3	3	1	1	0	0	10
Staff	1	0	1	0	2	0	0	0	0	1	5
Employment duration (years)											
1-3	7	6	26	10	76	98	49	62	12	4	350
3-5	1	3	4	3	12	10	6	6	5	5	55
5-10	1	0	1	0	1	0	1	1	0	0	5
10-20	2	1	4	0	7	4	1	1	0	3	23
>20	2	4	4	3	15	7	5	3	2	6	51
Total users' number											
(people)	13	14	39	16	111	119	62	73	20	18	485

The observation and survey results were discussed on a per-segment basis to examine the sidewalk quality in detail. Table 6 provides data on walking frequency and **Error! Reference source not found.** shows reasons for not using sidewalks broken down by segmentation.

Table 6. Walking frequency in campus environment

Segmentation	Walking >20m frequency	
	Not frequently *(people)*	Frequently *(people)*
Segment A	31%	69%
Segment B	14%	86%
Segment C	21%	79%
Segment D	19%	81%
Segment E	21%	79%
Segment F	21%	79%
Segment G	19%	81%
Segment H	19%	81%
Segment I	10%	90%

The data inTable ***6*** demonstrates that there are individuals in all segments who frequently walk on the campus but do not use the sidewalks. It can be seen by significantly higher numbers of people that do walking activity within the campus than people who claim to frequently use the sidewalks. This finding confirms the issue addressed in the research. Moreover, it also shows that in sidewalk segments C, D, E, F, G, H, and I, pedestrians' reasons for not using sidewalks are predominantly due to discomfort, while pedestrians in segment A feel that sidewalks are not helpful.

Table 7. Mode value of sidewalks physical quality assessment by pedestrians

Variables	Mode value
Height	4
Width	4
Material	4
Connectivity	4
Obstacles	4
Shade	3

Table 7 shows the mode values of the sidewalk physical quality assessments. The mode value represents the most frequently occurring value in a dataset. In the survey conducted, physical sidewalk quality was assessed using numerical values where (a) a value of 5 indicated excellent quality, (b) a value of 4 indicated good quality, (c) a value of 3 indicated average quality, (d) a value of 2 indicated poor quality, and (e) a value of 1 indicated very poor quality. From the data processed in Table 7, it can be seen that the overall physical quality of the sidewalks in all segments is rated as good. However, the shading aspect is rated as "3" or average by sidewalk users.

In this study, 2 regression analyses have been conducted to understand pedestrian behavior in using the sidewalks. The analysis began with normalizing and tabulating survey questionnaire result. The analyses are divided into 2 independent variables: (a) sidewalk physical score; and (b) walkability score. Analysis A: the physical score including the height, width, and groundcover material, while Analysis B: walkability including the quality of sidewalk connectivity, the obstacles and if the pedestrian need shading system. The dependent variable is pedestrians' frequency in using the sidewalk. Result shows a significant difference between analysis A (Table 8) and analysis B (Table ***9***).

Table 8. Regression analysis result on sidewalk usage frequency depends on the quality of sidewalk walkability variables

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.192	.142		8.375	.000
	Walkability	.096	.038	.175	2.529	.012

a. Dependent Variable: Pedestrians' frequency in using sidewalks

Table 9. Regression analysis result on sidewalk usage frequency depends on the physical quality of the sidewalk

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.216	.199		6.123	.000
	Physical quality	.079	.048	.116	1.663	.098

a. Dependent Variable: Pedestrians' frequency in using sidewalks

The results show that walkability variables play more significant role on how frequent the pedestrians use the sidewalks in Polnep campus area. It can be seen from the p-value (Sig.) from both results. The regression analysis on variable walkability quality shows the p-value of 0,012 while variable of sidewalks quality shows the p-value of 0,098. The p-value < 0,05 considered statistically significant and indicate a meaningful impact, while p-value > 0,05 implies lack of statistical significance.

4.1 Discussion and Research Synthesis

The study's primary objective was to investigate the reasons behind pedestrians' reluctance to use sidewalks. The results revealed that only 57% of the 160 pedestrians utilized the sidewalks, a phenomenon primarily attributed to the perceived lack of comfort on these pathways. An evaluation based on the physical standards outlined by PUPR documentation indicated that frequently used sidewalks, specifically segments E and F, met the minimum requirements. However, approximately 50% of pedestrians in both segments opted not to walk on the sidewalks, a pattern observed across various sidewalk segmentations in Polnep campus, prompting a deeper exploration into the root cause.

To address the missing link, a series of further analyses were undertaken, starting with an examination of the mode values. The data unveiled that the shading quality score was notably the lowest, marked as 3, while other variables such as height, width, floor material, connectivity, and obstacles on the sidewalks had mode values of 4. This led to the assumption that the absence of shading might be a significant factor contributing to pedestrians' avoidance of sidewalks.

To validate this assumption, a linear regression analysis was conducted, revealing that overall walkability variables, including connectivity, shading systems, and sidewalk obstacles, significantly influenced pedestrians' frequency of sidewalk usage, with a p-value of 0.012. This finding aligns with previous studies emphasizing the importance of good shading and connectivity for increased walkability [2]. Other study was conducted at the University of Indonesia, also support the notion that user comfort plays a pivotal role in sidewalk [12]. Similarly, research in Padang identified disturbances caused by illegal street vendors on sidewalks, resulting in sidewalk ineffectiveness [13]

In essence, these findings validate the initial observations of the study, shedding light on why sidewalks that comply with standards are not frequently used by pedestrians. By uncovering this novel phenomenon in the context of Indonesia's built environment, this study contributes to and complements existing research on sidewalk usage and comfort.

V. CONCLUSION

In conclusion, this study delved into the intricate dynamics influencing pedestrians' choices to forego frequently used sidewalks in Politeknik Negeri Pontianak campus, despite meeting established standards. The primary factor identified was the perceived lack of comfort, as evidenced by the low shading quality scores. Subsequent analyses, including mode values and linear regression, underscored the significance of walkability variables, particularly shading systems and connectivity, in shaping pedestrians' frequency of sidewalk usage. These findings align with prior studies, highlighting the critical role of user comfort in sidewalk effectiveness. By offering novel insights into sidewalk usage within Indonesia's built environment, this study contributes valuable perspectives to the broader discourse on pedestrian behavior and urban infrastructure planning.

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