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ANALYSIS OF WALKABILITY INDEX AND THERMAL COMFORT AND THEIR EFFECT ON WALKING INTENTION THROUGH PEDESTRIAN SATISFACTION ON JENDERAL SUDIRMAN STREET, JAKARTA

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Abstract

This study examines the influence of the walkability index and thermal comfort on pedestrians' interest in walking, with satisfaction serving as an intervening variable, along Jalan Jenderal Sudirman in Jakarta. A combined approach was used, including an assessment of the walkability index based on Bina Marga Guideline No. 05/P/BM/2023, measurement of thermal comfort using the Temperature Humidity Index (THI), and SEM-PLS with 100 respondents. The walkability index reached 86.10 (Very Good). The THI indicated that shaded areas were comfortable (28.59–28.86), while unshaded areas were uncomfortable (29.28). Six out of seven SEM-PLS hypotheses were significant. Walkability significantly influences satisfaction ($\beta = 0.663$, $p = 0.000$) and interest in walking ($\beta = 0.401$, $p = 0.000$). Thermal comfort significantly influences satisfaction ($\beta = 0.198$, $p = 0.026$), but does not directly influence interest in walking. Thermal comfort significantly influences walking interest through satisfaction ($\beta=0.088$, $p=0.050$), indicating that satisfaction fully mediates this hypothesis. Satisfaction significantly influences walking interest ($\beta=0.445$, $p=0.000$). The model explains 58.7% of the variance in satisfaction and 73.1% of the variance in interest in walking.

Keywords: SEM-PLS; temperature humidity index; thermal comfort; walkability index; walking interest; pedestrian satisfaction

INTRODUCTION

Jalan Jenderal Sudirman, a secondary arterial corridor that runs through Jakarta's Central Business District (CBD), is one of the roads that the Jakarta Provincial Government has equipped with pedestrian facilities over the past six years, since 2022, with a total length of 214.62 km across the Jakarta Special Capital Region, in line with large-scale infrastructure projects such as Transjakarta, MRT, LRT, and KRL (Institute for Transportation and Development Policy (ITDP), 2023). Urbanization in Jakarta has driven economic growth and created job opportunities, but it has also led to severe traffic congestion, deteriorating air quality, high population density, and regional development disparities, all of which have negatively impacted the quality of life and productivity of the population (Carolin & Kurniati, 2025). In an effort to address the challenges of urbanization by 2030, the Sustainable Development Goals (SDGs) have established sustainable cities and communities as Goal 11 (Ganesha & Husein, 2024). Sustainable Development Goal (SDGs) 11, "Sustainable Cities and Communities," emphasizes the importance of creating sustainable, environmentally friendly, and livable cities as part of global efforts to achieve other development goals such as poverty eradication, health, and education (Department of Economic and Social Affairs, 2025). The high intensity of pedestrian movement along this corridor makes it one of the most strategic pedestrian pathways in Indonesia and a relevant object of study for evaluating the quality of pedestrian facilities within the context of sustainable transportation. Speck's (2013) General Theory of Walkability states that the level of walkability in an urban environment is determined by the availability of public services accessible on foot, the comfort and safety of streets, and the attractiveness of the area in terms of architectural design and social context (Gorrini, Presicce, Messa, & Choubassi, 2023). The concept of a pedestrian-friendly city emphasizes cities that have a high level of walkability, where walkability is defined as the level of accessibility of an area within walking distance

from a building to its destination (Sofwan & Tanjung, 2020). Improving integrated connectivity and accessibility between land use and transportation is crucial to creating sustainable and livable cities (Mengiste et al., 2025). Walkability is a key indicator in assessing whether an urban environment supports walking activities. This concept encompasses accessibility, safety, comfort, and the completeness of pedestrian facilities. Previous studies in Indonesian urban areas have confirmed a positive correlation between walkability quality and pedestrians' satisfaction and walking intention. However, studies integrating thermal comfort as a variable jointly influencing walking behavior remain limited in Indonesia.

According to ASHRAE Standard 55 (2017), thermal comfort is "a state of mind that expresses satisfaction with the thermal environment and is assessed through subjective evaluation" (Mat Alias & Kassim, 2023). Thermal comfort is defined as a person's state of mind that expresses satisfaction with the thermal environment (Arinta & Hapsari, 2022). Thermal comfort along pedestrian pathways is a critical factor affecting pedestrians' experiences and walking decisions, particularly in tropical cities with high solar radiation intensity. Identifying the relationship between human thermal perception and walkability can help in the development of more comfortable walking environments (Jia, Wang, Wong, Chen, & Ding, 2022).

THI is a quantitative analysis developed by Nieuwolt in 1975 using two indicators: temperature (°C) and humidity (%) (Milantara, Asriani, & Haria Aditia Putra, 2023). Temperature-Humidity Index (THI) is an important method and tool for measuring thermal comfort, which helps identify environmental conditions that can affect human physical and mental well-being (Achmad Zaky et al., 2023). Studies in various contexts indicate that thermally uncomfortable conditions significantly reduce walking interest and duration, even in corridors with adequate physical facilities. Along Jenderal Sudirman Street, the presence of shading from trees and buildings creates variations in thermal conditions that require quantification.

This study addresses the existing research gap by simultaneously integrating three analytical approaches: (1) walkability index assessment based on the latest national standards, (2) thermal comfort measurement using the Temperature Humidity Index (THI), and (3) modeling the influence of these two variables on walking intention through pedestrian satisfaction using SEM-PLS. The objectives of this study are to: (1) analyze the walkability index of the pedestrian pathway along Jenderal Sudirman Street; (2) analyze the level of thermal comfort; and (3) examine the influence of walkability and thermal comfort on walking intention through pedestrian satisfaction as an intervening variable.

METHOD

This study employed a quantitative approach using three analytical methods applied in parallel. The research location was the pedestrian pathway along Jenderal Sudirman Street, Jakarta, which was divided into eight observation segments extending from Bundaran HI to Tugu Pemuda Membangun (Figure 1).

Figure 1. Research Location Map and Division of Walkability Index Segments

The walkability index was assessed based on the Bina Marga Guideline No. 05/P/BM/2023, which includes seven parameters: (1) condition and quality of pedestrian pathways, (2) supporting facilities (amenities), (3) supporting infrastructure for pedestrians with disabilities, (4) obstructions, (5) availability and condition of crossings,

(6) pedestrian conflicts with other transportation modes, and (7) security from crime. Assessments were conducted in both directions (normal and opposite) for each segment.

Thermal comfort was measured using the Temperature Humidity Index (THI) method with the following formula:

$$\mathrm{THI} = 0.8\mathrm{T} + \frac{\mathrm{RH} \times \mathrm{T}}{500}$$

Where T represents air temperature (°C) and RH represents relative humidity (%). Measurements were conducted at eight observation points under three shading conditions: Tree Shade (TS), Building Shade (BS), and No Shade (NS), during three different periods (morning, afternoon, and evening). The comfort categories were classified as follows: THI < 29 = Comfortable; 29–30.5 = Uncomfortable; and > 30.5 = Very Uncomfortable (Helmy Nadhifa, Budiarti, & Damayanti Twinsari Manningtyas, 2023).

For the influence analysis, data were collected through questionnaires distributed to 100 pedestrians using a purposive sampling technique. The research variables consisted of thermal comfort (X1, 2 formative indicators), walkability (X2, 7 formative indicators), pedestrian satisfaction (Z, 3 formative indicators), and walking intention level (Y, 4 reflective indicators). Data analysis was conducted using SEM-PLS with SmartPLS 4.0, including outer model and inner model evaluations (F. Hair, M. Hult, Ringle, & Sarstedt, 2022).

RESULTS AND DISCUSSION

Walkability Index

The results of the walkability index assessment for each segment are presented in Table 1. The assessment was conducted in two directions: Normal (N) and Opposite (O).

Table 1. Recapitulation of Walkability Index by Segment

Segment	Normal WI	Category	Opposite WI	Category
1	92.38	Excellent	92.38	Excellent
2	91.43	Excellent	71.43	Good
3	81.43	Excellent	81.43	Excellent
4	88.57	Excellent	88.57	Excellent
5	82.86	Excellent	88.57	Excellent
6	90.00	Excellent	92.86	Excellent
7	80.00	Good	90.00	Excellent
8	77.14	Good	88.57	Excellent
Average	85.48	Excellent	88.73	Excellent

Table 2. Recapitulation of Walkability Index by Parameter

Parameter	Normal WI	Category	Opposite WI	Category
1	92.50	Excellent	95.00	Excellent
2	100.00	Excellent	95.00	Excellent
3	90.00	Excellent	92.50	Excellent
4	95.00	Excellent	100.00	Excellent
5	75.83	Good	75.83	Good
6	65.00	Fairly Good	68.75	Good
7	80.00	Good	80.00	Good
Average	85.48	Excellent	88.73	Excellent

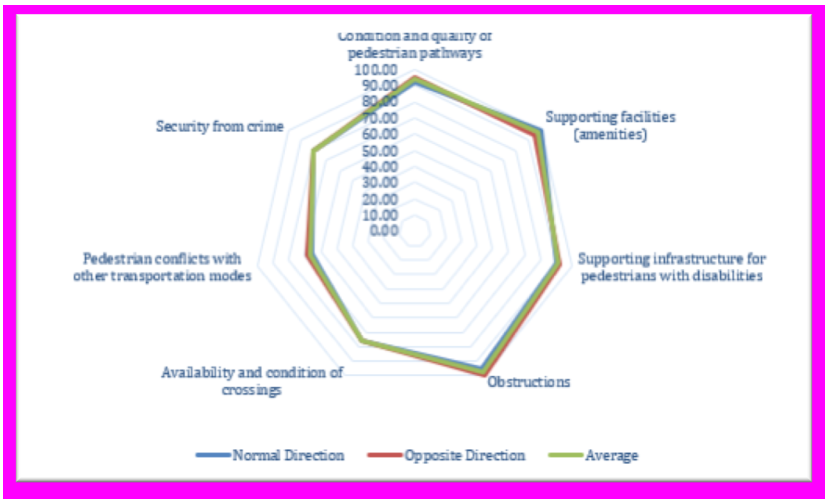

Figure 2 Walkability Index of Jenderal Sudirman Street

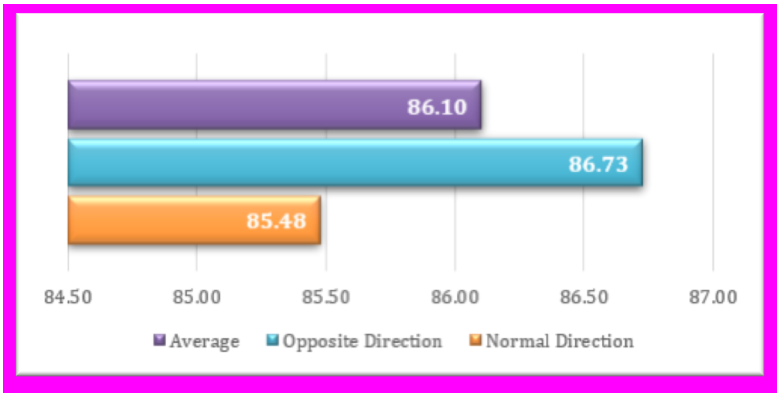

Figure 3 Average Walkability Index of Jenderal Sudirman Street

The overall walkability index score of Jenderal Sudirman Street was 86.10, which falls within the "Excellent" category (>80) based on the Bina Marga Guideline No. 05/P/BM/2023. Segment 1 consistently recorded the highest score (92.38) in both directions. Meanwhile, Segment 8 in the normal direction and Segment 2 in the opposite direction recorded the lowest scores, primarily due to suboptimal sidewalk conditions and inadequate infrastructure for people with disabilities. The parameters that consistently obtained the lowest scores in both directions were pedestrian conflicts with other transportation modes and the availability and condition of crossings (65.00–75.83), indicating that safety aspects still require special attention (van der Vlugt et al., 2025). These findings are consistent with the study conducted by (Sofwan & Tanjung, 2020) in the Pekanbaru CBD area, which found that major business districts tend to have better pedestrian infrastructure compared to other urban areas.

Thermal Comfort

The results of the THI measurements are presented in Table 2 and Figure 2.

Table 3. Recapitulation of THI Values on Jenderal Sudirman Street

Time	NS	Category	BS	Category	TS	Category
Morning	29.02	Uncomfortable	28.86	Comfortable	28.49	Comfortable
Afternoon	30.16	Uncomfortable	29.43	Uncomfortable	29.14	Uncomfortable
Evening	28.66	Comfortable	28.29	Comfortable	28.13	Comfortable
Average	29.28	Uncomfortable	28.86	Comfortable	28.59	Comfortable

Figure 4. THI Graph of Jenderal Sudirman Street Based on Time Period and Shading Condition

The analysis results indicate that the presence of shading plays a significant role in determining the level of thermal comfort. Areas shaded by trees recorded an average THI of 28.59 (Comfortable), while areas shaded by buildings recorded an average THI of 28.86 (Comfortable). In contrast, areas without shading had an average THI of 29.28 (Uncomfortable). The most critical condition occurred during the afternoon in areas without shading, with a THI value of 30.16 (Uncomfortable), which is consistent with the findings of Jia et al. (2022) that direct exposure to solar radiation in tropical conditions significantly increases pedestrian discomfort.

Overall, the average THI value of Jenderal Sudirman Street was 28.91, which falls within the comfortable category. However, variations in thermal conditions across different time periods and shading conditions indicate the need for interventions through the addition of shading elements in segments that still lack adequate shade (Nasrollahi, Ghosouri, Khodakarami, & Taleghani, 2020) (Natabara, Pamurti, & Pamurti, 2023).

SEM-PLS Analysis

The developed SEM-PLS model showed an R^2 value of 0.587 for the satisfaction variable and 0.731 for the walking intention variable (Table 4), indicating strong predictive capability of the model. Figure 3 presents the structural model with path coefficient values at a 5% significance level**.**

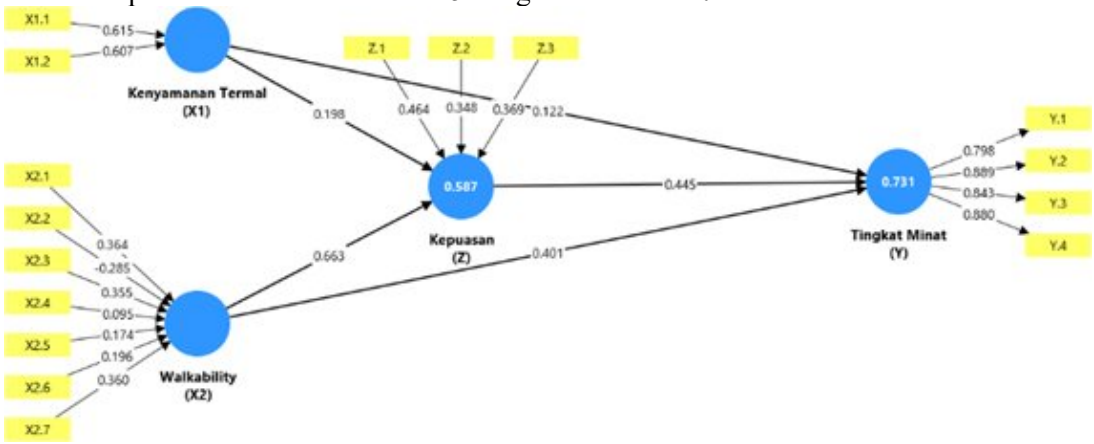

Figure 3. SEM-PLS Structural Model

Table 3. Results of SEM-PLS Hypothesis Testing

No	Hypothesis	Path Coeff.	T-Stat	P-Value	Decision
H1	Thermal Comfort → Satisfaction	0.198	2.220	0.026	Significant
H2	Thermal Comfort → Walking Intention	0.122	1.956	0.051	Not Significant
H3	Walkability → Satisfaction	0.663	8.019	0.000	Significant
H4	Walkability → Walking Intention	0.401	3.767	0.000	Significant
H5	Satisfaction → Walking Intention	0.445	4.008	0.000	Significant
H6	Thermal Comfort → Satisfaction → Walking Intention	0.088	1.964	0.050	Significant
H7	Walkability → Satisfaction → Walking Intention	0.295	4.463	0.001	Significant

Table 4. Model R-Square Values

Variable	R-Square	Interpretation
Satisfaction (Z)	0.587	Moderate
Walking Intention Level (Y)	0.731	Moderate

Walkability was identified as the dominant predictor in this model, significantly influencing satisfaction ($\beta = 0.663$, $p < 0.001$) and directly influencing walking intention ($\beta = 0.401$, $p < 0.001$). The magnitude of the walkability path coefficient toward satisfaction (0.663) was substantially greater than that of thermal comfort (0.198), indicating that the quality of physical infrastructure is the primary determinant of pedestrian satisfaction along this corridor. These findings are consistent with the study conducted by (Rahmatiani & Kameswara, 2021), which identified a strong correlation between walkability quality and pedestrian satisfaction in the Sudirman commercial district.

Thermal comfort significantly affected satisfaction ($\beta = 0.198$, $p = 0.026$), but did not directly influence walking intention ($p = 0.051$). The non-significant direct effect indicates that thermal comfort functions more as a factor influencing pedestrians' satisfaction evaluation of the pedestrian pathway rather than as a direct determinant of the decision to walk. This finding may be explained by the urban context in which most pedestrians are commuters who walk primarily due to the need for access to public transportation modes; therefore, walking decisions are not solely determined by thermal conditions (Jia et al., 2022).

Satisfaction was proven to play an important mediating role. Satisfaction acted as a full mediator in the relationship between thermal comfort and walking intention (H6, $\beta = 0.088$, $t = 1.964$) and as a partial mediator in the relationship between walkability and walking intention (H7, $\beta = 0.295$, $t = 4.463$). This mediation pattern indicates that efforts to improve thermal comfort will effectively increase walking intention only if they first succeed in enhancing pedestrian satisfaction. The R^2 value of 0.731 for the walking intention variable indicates that the two investigated variables were able to explain 73.1% of the variation in walking intention, which is relatively high for a transportation behavior model. This study used Partial Least Squares-based Structural Equation Modeling (SEM-PLS) as a data analysis tool. All testing procedures followed the guidelines provided by (F. Hair et al., 2022) (Savitri et al., 2021) (Muhson, 2022). Model evaluation was conducted in two main stages: evaluation of the outer model (measurement model) and evaluation of the inner model (structural model).

CONCLUSION

Based on the analysis results, three main conclusions can be drawn. First, the walkability index of Jenderal Sudirman Street, Jakarta, was 86.10, which falls within the Excellent category based on the Bina Marga Guideline No. 05/P/BM/2023. However, the parameters related to pedestrian conflicts with other transportation modes and the availability of crossings remain aspects that require improvement as preventive measures.

Second, thermal comfort varied significantly depending on the presence of shading. Shaded areas were categorized as comfortable (THI 28.59–28.86), while unshaded areas were categorized as uncomfortable (THI 29.28), particularly during the afternoon period (THI 30.16).

Third, the SEM-PLS results demonstrated that walkability significantly influences satisfaction and walking intention, both directly and indirectly through satisfaction (partial mediation). Thermal comfort significantly influences satisfaction; however, its influence on walking intention occurs only through the full mediation of satisfaction. The practical implication of this study is that the primary priority for improving the quality of pedestrian

pathways along Jenderal Sudirman Street should focus on reducing conflicts between transportation modes and adding shading elements in segments that still lack adequate shade.

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