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From Environment to Accidents: Understanding Pedestrian Safety through Spatial Analysis in Taipei

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Abstract: In recent years, the concept of "pedestrian justice" has gained increasing attention. Particularly in Taipei City, characterized by its highly convenient public transportation system, ensuring pedestrian safety has emerged as a critical issue in urban planning. This study quantifies walking environment indicators across four key dimensions: Passability, Safety, Convenience and Land Use, and Aesthetics. By employing spatial analysis methods such as Global Moran's I, Local Moran's I, and Bivariate Local Indicators of Spatial Association (Bivariate LISA), this research investigates the spatial impact and relationship between the walking environment and pedestrian-vehicle traffic accidents.

Keywords: walkability; pedestrian safety; spatial analysis; pedestrian-vehicle accidents

1. Introduction

Taiwan is often described as a "living hell for pedestrians," largely due to a walking environment shaped by early vehicle-oriented planning[1,2]. Many urban roads are inherited from early settlement patterns, resulting in narrow corridors with limited space for pedestrians. These conditions have collectively contributed to an unfriendly pedestrian environment across the country.

In recent years, however, planning priorities have shifted from vehicle-centric to people-centric. The government has actively promoted human-oriented transportation, placing greater emphasis on pedestrian safety and the creation of more humanized urban spaces. As both central and local governments advance these policies, improvements in the walking environment are gradually emerging.

To support these efforts, this study examines the relationship between the walking environment and pedestrian–vehicle accidents through four dimensions: passability, safety, convenience and land use, and aesthetics. By integrating spatial analysis of accident locations with walking-environment characteristics, this research identifies key factors influencing pedestrian safety, providing evidence for future planning and contributing to more sustainable, human-centered urban development.

2. Area of study

This study focuses on the Da'an and Xinyi Districts in Taipei City, Taiwan (Figure 1). As the core administrative districts of Taipei, this area is characterized by diverse land use zoning, including residential, commercial, and educational zones. The region exhibits high levels of human activity and high densities of both pedestrian and vehicular traffic.

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Furthermore, it features a diverse built environment—encompassing both traffic and pedestrian infrastructures—and provides sufficient accident data for analysis.

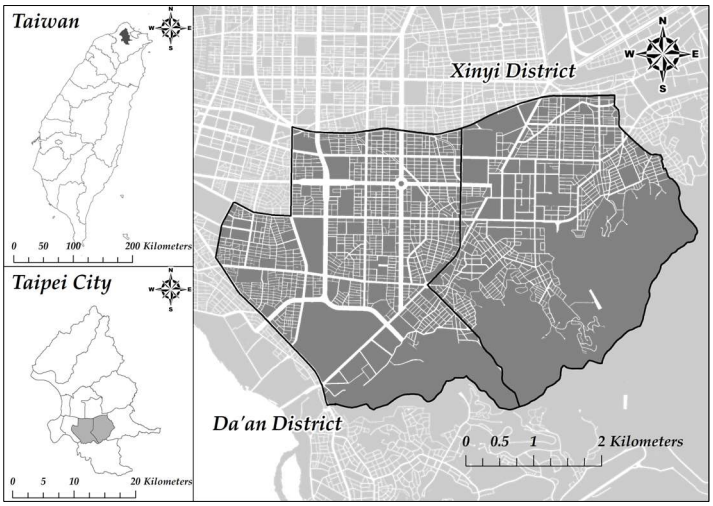

Figure 1. Study area.

3. Methodology

3.1. Definition of Spatial Units

In this study, the spatial units were defined based on road centerlines. Roads were segmented at 10-meter intervals, with the left and right sides of each segment treated as independent units (Figure 2).

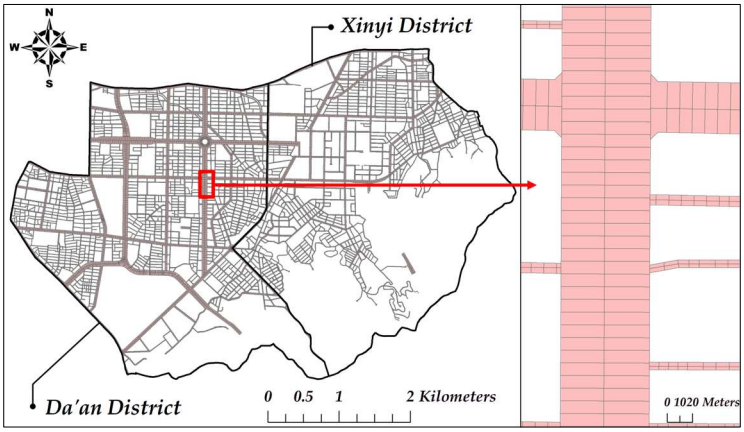

Figure 2. Spatial Unit.

3.2. Construction of Walking Environment Indicators

Existing literature offers diverse frameworks for assessing walking environments. Core dimensions such as safety, comfort, and convenience are widely emphasized in foundational studies and official guidelines [2–5]. Furthermore, the impact of the built environment and land use—including zoning mix and road geometry—has been highlighted as critical for pedestrian activity [6,7]. Aesthetics and attractiveness were also identified as significant factors influencing walking willingness [3,6]. Synthesizing these perspectives, this study establishes an assessment framework comprising four key dimensions—Passability, Safety, Convenience and Land Use, and Aesthetics—encompassing a total of 15 sub-indicators (Table 1).

Table 1. The assessment framework of walking environment indicators.

Dimension	Indicator
Passability	B1 Effective Sidewalk Width, B2 Sidewalk Continuity, B3 Road Connectivity, B4 Sidewalk Ratio
Safety	B5 Pavement Quality, B6 Street Lighting Level, B7 Traffic Signal Facilities, B8 Marked Pedestrian Lanes
Convenience and Land Use	B9 Sidewalk Connectivity, B10 Access to Service Facilities, B11 Land Use: Residential, B12 Land Use: Commercial, B13 Land Use: Mixed Residential, B14 Availability of Resting Spaces
Aesthetics	B15 Street Trees

3.3. Spatial Analysis Methods

This study employs **Global Moran's I** to examine the spatial autocorrelation of pedestrian-vehicle traffic accidents and walking environment indicators. Subsequently, Bivariate Local Indicators of Spatial Association **(Bivariate LISA)** are utilized to investigate the spatial correlation between the walking environment and traffic accidents. In this analysis, pedestrian-vehicle traffic accidents are defined as the dependent variable (A), while walking environment indicators serve as the independent variable (B).

4. Results

4.1. Global Moran's I

The results of Global Moran's I indicate that pedestrian-vehicle traffic accidents and all independent variables within the study area exhibit positive spatial autocorrelation(Table 2). Specifically, variables with a Moran's I value greater than 0.8 are classified as showing high positive spatial autocorrelation (indicated in bold in the table), while those with values less than 0.5 are considered to show low positive spatial autocorrelation.

Table 2. Results of Global Moran's I analysis for pedestrian-vehicle accidents and walking environment indicators.

Dimension	Code	Moran's Index	Expected Value	Variance	z-score	p-value
Accidents	**A1**	**0.864083**	**-0.000016**	**0.000006**	**340.0759**	**< 0.001**
Passability	B1	0.736840	-0.000016	0.000006	289.9286	< 0.001
	B2	0.277544	-0.000170	0.000551	11.8339	< 0.001
	B3	**0.996943**	**-0.000016**	**0.000006**	**392.2434**	**< 0.001**
	B4	0.768236	-0.000016	0.000006	302.2553	< 0.001
Safety	**B5**	**0.835658**	**-0.000016**	**0.000006**	**328.7844**	**< 0.001**
	B6	0.699447	-0.000016	0.000006	276.2439	< 0.001
	B7	**0.931187**	**-0.000016**	**0.000006**	**366.3748**	**< 0.001**
	B8	**0.831525**	**-0.000016**	**0.000006**	**327.1629**	**< 0.001**
Convenience and Land Use	B9	0.728160	-0.000016	0.000006	291.7266	< 0.001
	B10	**0.975173**	**-0.000016**	**0.000006**	**383.6886**	**< 0.001**
	B11	**0.854690**	**-0.000016**	**0.000006**	**336.2700**	**< 0.001**
	B12	**0.881764**	**-0.000016**	**0.000006**	**346.9271**	**< 0.001**
	B13	**0.848824**	**-0.000016**	**0.000006**	**333.9612**	**< 0.001**
	B14	0.215414	-0.000016	0.000006	84.9913	< 0.001
Aesthetics	B15	0.549889	-0.000016	0.000006	216.3862	< 0.001

4.2. Bivariate LISA

As shown in Table 3, a Mean Local Moran's I greater than 0 indicates a positive spatial association between the independent variable and the dependent variable (A1).

Specifically, indicators B1, B5, B12, and B13 exhibit relatively high positive values. Conversely, a value less than 0 implies a negative spatial association, with indicators B8 and B11 showing lower negative values.

Table 3. Summary of Bivariate LISA results between walking environment indicators and traffic accidents.

Independent Variable		Mean Local Moran's I	Mean p-value	Significant Areas (p<0.05)	
				Count	Percentage
Passability	B1	0.092	0.125	31,322	51.34%
	B2	0.038	0.194	10,859	17.80%
	B3	0.002	0.146	26,129	42.82%
	B4	0.000	0.167	12,864	21.08%
Safety	B5	0.117	0.090	21,852	35.81%
	B6	0.012	0.196	6,221	10.20%
	B7	0.049	0.194	20,095	32.94%
	B8	-0.039	0.263	15,602	25.57%
Convenience and Land Use	B9	-0.010	0.172	24,524	40.19%
	B10	0.040	0.194	15,592	25.55%
	B11	-0.092	0.047	50,156	82.20%
	B12	0.093	0.223	15,313	25.10%
	B13	0.070	0.052	47,250	77.44%
	B14	-0.009	0.028	60,413	99.01%
Aesthetics	B15	-0.019	0.362	11,835	19.40%

Note: The dependent variable for all pairs is Pedestrian-Vehicle Accidents (A1).

5. Conclusion

Based on the analytical results, Marked Pedestrian Lanes (B8) and Residential Land Use (B11) exhibited lower Mean Local Moran's I values, reflecting a potential protective effect on pedestrian safety. Furthermore, the Availability of Resting Spaces (B14) warrants special attention, demonstrating an exceptionally high proportion of significant spatial clustering (99.01%). Consequently, this study preliminarily suggests that enhancing these specific walking environment features—namely Marked Pedestrian Lanes, Residential Land Use, and the Availability of Resting Spaces—may effectively mitigate the occurrence of pedestrian-vehicle traffic accidents.

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Conflicts of Interest: The authors declare no conflict of interest.

References

1. Directorate General of Highways, MOTC. *Insistence on Change and Constancy: 65th Anniversary Special Issue*; Directorate General of Highways, MOTC: Taipei, Taiwan, **2011**. (In Chinese).
2. Construction and Planning Agency, Ministry of the Interior. *Design Manual of Urban Roads for Human-Oriented Transportation*, 2nd ed.; Construction and Planning Agency, Ministry of the Interior: Taipei, Taiwan, **2021**. (In Chinese).
3. Khisty, C.J. Evaluation of pedestrian facilities: Beyond the Level-of-Service concept. *Transp. Res. Rec.* 1994, *1438*, 45–50.
4. Tsao, C.-W. A Study of Development and Application of Comprehensive Index of the Pedestrian Space. Master's Thesis, National Taiwan University, Taipei, Taiwan, **2003**.
5. Chen, S.-T. Sidewalk Pedestrian Flow Estimation: Application of Service Evaluation for Sidewalk Systems. Master's Thesis, National Yang Ming Chiao Tung University, Hsinchu, Taiwan, **2021**.
6. Lei, H.-Y. Evaluation Indicators for Urban-Friendly Walkable Environments. Master's Thesis, National Chiayi University, Chiayi, Taiwan, **2014**.
7. Huang, Y.-T. The Influence of Built Environment and Traffic Environment on Pedestrian-Vehicle Incidents: A Case Study in Chongxin and Chongxue Village in East District, Tainan City. Master's Thesis, National Cheng Kung University, Tainan, Taiwan, **2023**.