Walking in the city of footbridges: Sense of community, subjective walkability and walking habits in a layered neighborhood

Abstract

This paper explores the concept of sense of community (SoC) in Tsuen Wan, Hong Kong, an urban area where layered pedestrian networks heavily influence physical and social connections. This study examines how Tsuen Wan's network of footbridges and sidewalks shapes different walking habits, perceived walkability and SoC. Utilizing a questionnaire survey and generalized structural equation modeling (GSEM), the research reveals key distinctions in how these urban infrastructures impact the social fabric. The findings show that while frequent leisurely walking on sidewalks is positively linked to subjective walkability, it negatively affects SoC. Conversely, spending more time on leisurely walks on sidewalks enhances SoC, suggesting that duration, rather than frequency, is linked to stronger community ties. In contrast, both the frequency and duration of utility walking, whether on footbridges or sidewalks, are negatively associated with subjective walkability and SoC. The study also highlights that gender and income significantly are associated with SoC, with males and higher-income individuals reporting stronger SoC and greater walkability satisfaction, suggesting that social and economic capital, as well as safety perceptions, are key factors. Additionally, local Hongkongers exhibit a higher SoC despite walking less for leisure, likely due to strong social and network capital that sustains community bonds even with fewer casual interactions. This research contributes to the SoC and transportation literature by emphasizing both the mobility and social functions of urban streets. It underscores the need for urban planning that supports both transient and sustained social interactions, recognizing the importance of diverse, mobile experiences in fostering a dynamic and inclusive SoC.

Keywords: Sense of community; Subjective walkability; Sociality of walking; Mobility; Footbridge; Hong Kong

1. Introduction

Urbanization has significantly transformed city landscapes, replacing traditional streetscapes with complex networks of roads, tunnels, and elevated walkways (Chan et al., 2025a, 2025b, 2022a; Choi et al., 2023; Guo and Loo, 2013; Wang, 2020; Xu et al., 2022; Zacharias and He, 2018; Zhao et al., 2020). While these infrastructures enhance mobility and connectivity, they also reshape how and where social interactions occur. In particular, pedestrian footbridges—designed to separate pedestrians from vehicular traffic, reduce congestion, and optimize vertical space—have become a defining feature of many urban environments, including Hong Kong's Tsuen Wan district (**Figure 1**). Often referred to as a 'footbridge city', Tsuen Wan has an extensive footbridge network connecting residential areas, commercial centers, and transit hubs (Chan et al., 2022b; Sun et al., 2021; Xu et al., 2024; Yue et al., 2024; Zhu et al., 2023). While these elevated pathways improve pedestrian flow and accessibility, they also raise questions about their impact on community life and social cohesion (Woo and Malone-Lee, 2014).

Figure 1 Illustration of the comprehensive footbridge in the Tsuen Wan district as of May 2020 (adapted from HKSARG Highway Department, 2020)

Neighborhoods are often conceptualized as shared spaces that foster social ties. However, traditional definitions—such as statistical units or home buffer areas—may not fully capture how individuals experience and interact within their communities (Coulton et al., 2001; Loo, Lam et al., 2017). A key framework for understanding these interactions is Sense of Community (SoC), which refers to people's feelings about others who live in the same neighborhood (place rootedness) but can also extend to non-spatial communities based on shared interests or values (social bonding) (Long and Perkins, 2007; Zhang et al., 2022). A strong SoC fosters social capital, enhances well-being, and contributes to healthier urban environments (Loo, Mahendran et al., 2017). Studies in cities like Hong Kong, Singapore, and Tokyo highlight the influence of subjective walkability—a measure of the perceived friendliness of walking in an area—on both physical health and social engagement (Loo, Lam et al., 2017). However, as urban environments become increasingly structured around movement and mobility, the relationship between pedestrian infrastructure and community life remains underexplored.

Pedestrian footbridges are part of a broader trend in urban design aimed at improving mobility in densely populated areas (Lam and Yu, 2022; Tang et al., 2020; Wang et al., 2016). They offer advantages such as improved pedestrian safety, reduced street-level congestion, and enhanced walkability by providing weather-protected pathways (Zhu et al., 2023). At the same time, footbridges have also evolved into ‘marginal spaces’ where people gather, particularly among groups (Verebes, 2023; Villani et al., 2021; Villani and Talamini, 2020), particularly for domestic helpers (Lam and Yu, 2022; Mok and Ho, 2021). Despite these functions, their broader impact on local residents’ social interactions remains unclear. Unlike sidewalks, which have traditionally served as vibrant spaces for spontaneous encounters, footbridges—often enclosed and separated from the streets below—may create a sense of detachment from the surrounding environment (Barber, 2020; Tan and Xue, 2014; Woo and Malone-Lee, 2014).. This reduced connectivity could limit informal social interactions, potentially weakening SoC. Given that a strong SoC is associated with greater social cohesion, lower crime rates, and improved mental health, understanding how pedestrian infrastructure influences these dynamics is crucial (Loo et al., 2007).

This study investigates how Tsuen Wan’s layered pedestrian infrastructure—comprising both footbridges and at-grade sidewalks—shapes residents’ SoC by diversifying walking experiences within the same urban space. It examines how variations in walking habits—such as frequency and duration—across these infrastructures influence SoC and subjective walkability. Specifically, the study explores whether footbridges, which are often enclosed and detached from street-level social interactions, foster different perceptions of walkability and community connection compared to sidewalks, which are more integrated into everyday urban life. By adopting a quantitative approach, this research contributes to the “place” dimension of SoC, demonstrating how pedestrian infrastructure not only facilitates movement but also plays a crucial role in structuring social experiences within urban environments. The findings offer valuable insights for urban planners, policymakers, and architects seeking to design pedestrian networks that support both mobility and social cohesion in high-density cities.

2. Literature review

2.1 Sociality of walking on streets (and footbridges)

Theories on space and place play a crucial role in understanding the sociality of walking, particularly in urban environments like streets and footbridges. These theories explore how physical spaces are not just mere backdrops for human activity but shape social interactions, community engagement, and the broader socio-political landscape. Henri Lefebvre’s concept of the “*right to the city*”, articulated in his seminal work *The Production of Space* (1991), posits that urban spaces are essential to social life and democratic engagement. Lefebvre argues that the right to the city is more than just access to urban resources; it is the right to participate in the creation and transformation of urban spaces. Streets and footbridges, as integral components of urban environments, are central to this idea because they are the spaces where everyday social life unfolds (Chan et al., 2024a; Latham and Layton, 2019; Middleton, 2018). These spaces are not just transit routes but are sites where people engage in spontaneous interactions, form social bonds, and express their identities. For Lefebvre, the street is a quintessential example of public space that embodies the democratic potential of urban life. It is where the rhythms of daily life—walking, talking, trading, protesting—come together, making the street a vibrant and dynamic space of social interaction and community building. In contrast to Lefebvre's celebration of the street as a space of social engagement, Marc Auge (1995)'s notion of '*non-places*' offers a critical perspective on certain modern spaces that lack the capacity to foster meaningful social interactions. Auge describes non-places as spaces of transit, such as airports, highways, and some commercial areas, which are designed for efficiency and functionality rather than social interaction. These spaces, according to Auge, are characterized by their anonymity and lack of historical, relational, or cultural significance. While people may pass through these non-places, they do so in a state of solitude, disconnected from the social fabric that defines other urban spaces.

The distinction between Lefebvre's and Auge's concepts underscores the unique role of streets and footbridges in fostering community engagement. While some urban spaces may function as non-places, devoid of social meaning, streets and footbridges often resist this classification due to their inherent social functions (Chan, 2024; Simpson, 2008; Sun, 2022). footbridges, though primarily utilitarian, can also serve as symbolic and cultural landmarks that connect not just physical locations but also communities (Warnaby and Medway, 2008). They can host social events, become sites of collective memory, and even inspire communal pride. Similarly, streets are more than just pathways for movement; they are public stages where the social life of the city is performed. They accommodate a range of activities, from street markets to parades, which transform them into lively public spaces where people from diverse backgrounds can interact and engage with one another. The interplay between Lefebvre's and Auge's ideas reveals a tension in how urban spaces are perceived and utilized (Purcell, 2002). On one hand, the street is seen as a democratic space, rich with social potential, while on the other, the rise of non-places reflects a trend towards urban environments that prioritize functionality over sociality. This tension highlights the importance of intentional urban design and planning in preserving and enhancing the social roles of streets and footbridges. By recognizing the social and symbolic significance of these spaces, urban planners and policymakers can foster environments that support democratic engagement and community cohesion. Together, these perspectives illuminate the unique and critical roles that streets and footbridges play in fostering community engagement and sustaining the social fabric of urban life.

2.2 Developing sense of community on the move

Social interactions on streets and footbridges are central to the development of a SoC (Blokland et al., 2023; Chan et al., 2024a; Kim et al., 2024; Zahnow and Corcoran, 2024a, 2024b). These interactions can take many forms, from casual encounters between strangers to more organized communal activities. The diversity of interactions that occur in these spaces contributes to a rich social environment where people from different backgrounds can come together, share experiences, and build social ties. Casual encounters on streets and footbridges, such as greeting a neighbor, asking for directions, or simply making eye contact, may seem trivial, but they play a significant role in building a sense of community (Zahnow and Corcoran, 2024a). These small interactions contribute to what sociologist Erving Goffman (1963) called 'civil inattention', a form of social recognition that acknowledges the presence of others without requiring direct engagement. Civil inattention helps to create a sense of safety and familiarity on the streets, as people become accustomed to seeing familiar faces and recognizing others as part of the same community. Moreover, casual encounters on streets and footbridges can lead to more meaningful social interactions. For example, a brief exchange with a neighbor on the street can develop into a conversation, which in turn can lead to a deeper relationship. These interactions are the building blocks of social networks, which are essential for creating and sustaining a SoC. By providing opportunities for these encounters, streets and footbridges contribute to the social cohesion of a community.

In addition to casual encounters, streets and footbridges often serve as venues for organized activities that bring people together (Chan, 2024). Street markets and festivals are just a few examples of events that take place in these spaces. These activities not only draw people out into public spaces but also encourage them to interact with others in a shared social context. Organized activities on streets and footbridges are particularly important for fostering a sense of community because they provide opportunities for collective participation. Whether it is celebrating a local holiday, supporting a cause, or simply enjoying a street performance, these activities create a sense of shared purpose and identity (Kyle and Chick, 2007). They reinforce the idea that the street or footbridge is not just a space for individual movement but a communal space where collective life unfolds. Ng (2018) highlights the critical role of social capital, derived from place-based social networks, in cultivating SoC. Social capital refers to the resources and benefits individuals gain from their relationships and networks within a community, ranging from emotional support and shared information to collective action and community resilience (Schwanen et al., 2015). The everyday encounters that people have while on the move (Guzman et al., 2023; Middleton, 2018)—whether during their commute, running errands, or engaging in leisure activities—provide fertile ground for building and nurturing another form of capital, which Urry (2012) describes as 'network capital'. Network capital encompasses the benefits individuals gain from their non-immediate social networks, particularly those formed through mobility and transient interactions. Unlike traditional social capital, which is rooted in stable, place-based relationships, network capital arises from connections made across different social spaces as people move through them.

These connections, often characterized by their weak and informal nature, are crucial for broadening social horizons. Granovetter (1983)'s concept of weak ties describes these as instrumental in expanding an individual's social network. While they may not provide the same level of emotional support as strong ties, weak ties are essential for disseminating information across diverse social groups. They act as footbridges between different social circles, allowing ideas, opportunities, and resources to flow that might otherwise remain confined to a particular group. For SoC, weak ties link individuals to a broader community, introducing diversity into their social networks and exposing them to new perspectives and opportunities that they might not encounter within their immediate circle of close friends and family. This diversity is vital for fostering a dynamic and inclusive community where different voices and experiences are valued. This supports our assumption that walking on mobile places with various activities, in our case the sidewalk (**Figure 1**), contributes to SoC.

Material factors also plays a critical role in shaping the sociality of streets and footbridges and, by extension, the sense of community (Ramos-Vidal and de la Ossa, 2024; Rogers and Sukolratanametee, 2009). The way these spaces are designed can either enhance or inhibit social interactions, influencing the extent to which they contribute to a sense of community. One of the key factors that influence the sociality of streets and footbridges is walkability (French et al., 2014; Lund, 2002; Wood et al., 2010). Walkable streets are those that are safe, accessible, and comfortable for pedestrians. Features such as wide sidewalks, pedestrian crossings, street lighting, and traffic calming measures contribute to walkability by making streets more inviting for pedestrians. When people feel comfortable walking on streets and footbridges, they are more likely to use these spaces and engage in social interactions (Bozovic et al., 2020). Accessibility is also crucial for fostering sociality. Streets and footbridges that are easily accessible to people of all ages and abilities encourage a diverse range of users, which in turn enhances the social diversity of these spaces. Accessible design features, such as ramps, seating, and clear signage, make it easier for everyone to participate in the social life of the street or footbridge, thereby contributing to a more inclusive sense of community. While footbridges can improve accessibility by providing designated crossings at key locations, they sometimes come at the expense of pedestrian convenience (Soliz and Pérez-López, 2022). Unlike sidewalks, which allow for more direct movement, footbridges often require detours, adding extra time and effort to a pedestrian's journey (Xu et al., 2024). This paper investigates how different walking habits—such as walking for leisure versus utility as well as on sidewalks versus on footbridges—affect SW and SoC.

The presence of public spaces and amenities on streets and footbridges can significantly enhance their sociality (Loo and Fan, 2023; Loo and Zhang, 2024). Parks, plazas, benches, fountains, and public art installations are examples of features that can transform a street or footbridge into a lively social space. These amenities provide opportunities for people to stop, rest, and engage with their surroundings and with each other. Public spaces and amenities also serve as focal points for social interaction. For example, a plaza with seating and shade may become a popular spot for people to gather, chat, and relax. Similarly, a footbridge with a viewing platform or public art installation may attract people who stop to enjoy the view or take photos, creating opportunities for spontaneous social interactions. In Hong Kong, footbridges are utilized to separate vehicular traffic from pedestrian (Xu et al., 2024). They are also utilized as public space for various activities, but it is geographically vary (Siu et al., 2014; Siu and Huang, 2015). Activities are restricted through various rules and management decisions. For instance, various kinds of public activities can be found in outside the catchment areas of metro, depending on the context of place and time. In the streets near metro station and places of work, public activities will generally be conducted for business reasons; in the traditional street market areas, such as Tai Yuen Street, public activities can be quite comprehensive such as buying and selling, chatting, discussing, playing chess and even sleeping (Siu and Huang, 2015). By providing spaces where people can linger and interact, these amenities contribute to the social vibrancy of streets and footbridges and help to build SoC. In our case study area, the footbridges are narrower and do not physically allow space for activities other than walking for transportation (Chan, 2015). Consequently, activities tend to occur on the sidewalks at ground level. This can diminish the vibrancy of street life, as footbridges do not fully substitute for public open spaces at ground level (Woo and Malone-Lee, 2014). This research examines the different impacts of walking on streets and footbridges on SW and SoC, aiming to understand how urban infrastructure can support or hinder community building.

3. Data and methodology

3.1 Study context and data collection

There are over 1000 footbridge structures in Hong Kong currently and the number is expected to keep increasing (Highways Department, 2022, see also a comprehensive review of footbridges by Chan, 2023). Initially developed to improve internal circulation within commercial centers like Central, the integrated elevated pedestrian network later expanded to residential areas, such as Wah Fu and Shatin, during the city's rapid growth (Tan and Xue, 2016). Tsuen Wan, a district in Hong Kong with a well-developed footbridge system, was chosen as the study area due to its mixed residential and commercial character (see **Figure 1**). The footbridge system in Tsuen Wan is crucial for connecting pedestrian networks across the district. It links residential areas, commercial zones, and metro stations while safely separating pedestrians from vehicular traffic. This elevated walkway serves multiple functions for daily users, enhancing accessibility and connectivity in the district (Wang et al., 2016). However, this system sometimes requires pedestrians to take inconvenient detours, adding time and effort to reach destinations not designated by authorities (Xu et al., 2024). Additionally, there is concern that focusing too heavily on footbridge development may come at the expense of ground-level social life, potentially diminishing opportunities for community interaction (Woo and Malone-Lee, 2014).

3.2 Questionnaire design and administration

This study utilized a structured questionnaire to gather data on socio-demographics, walking habits, SW and SoC (see **Table 1**). The questionnaire was designed by integrating elements from previous studies on SoC and walkability. Wood et al. (2010) developed a 6-item Likert scale to measure pedestrians' SoC through neighborly attitudes, while He et al. (2021) created an 8-item Likert scale tailored to the Hong Kong environment. To assess SoC among pedestrians using both the footbridge network and at-grade sidewalks, this study combined questions from both scales. SW, another focus of the questionnaire, was measured by considering key factors such as accessibility, safety and security, environmental aesthetics, and comfort and usability—elements that have been identified in previous studies as significant to SW (Shatu et al., 2019; Van Cauwenberg et al., 2011; van der Vlugt et al., 2022). The dependent variables SoC and SW are measures based on multiple items as shown in **Table 1**. The Cronbach's alpha for SoC and SW are .821 and .860 respectively, suggesting good internal consistency. We confirm the structure of SoC and SW using exploratory factor analysis as 1-factor solution, considering factor 2 and above have eigenvalues < 1, which suggests over-extraction (too many factors). Additionally, following the approach of Wood et al. (2010), this study explored the relationship between SoC and walking frequency by asking respondents about their average time spent walking on footbridges and sidewalks. This approach allowed us to investigate the interplay between SW, SoC, and the frequency of travel on different path types.

Table 1 Description of the variables

Variable	Statement/question	Definition	Mean (SD)
Sociodemographic			
Gender	Male or female	0: Female ,1: Male;	0.56 (0.49)
Age	Age	1: 18 – 24; 2: 25 – 34; 3: 35 – 44; 4: 45 – 54; 5: 55 or above	2.10 (1.09)
Household income	Monthly household income in HKD	1: <$14999; 2: $15000 – 39999; 3: $40000 – 59999; 4: >$60000	2.00 (0.74)
HKer	Self-identified as Hongkonger	1: Yes, 0: Other	0.76 (0.42)
Walking habits			
Frequency	How often do you take a [utility/leisurely] walk on the [bridge/sidewalk]?	Continuous variable day/week	**Table 2**
Duration	On average, how much time do you spend walking on a [bridge/sidewalk] daily for [utility/leisure] purpose?	Continuous variable minutes/day	**Table 2**
Sense of community		Five-point Likert scale*	
Attitude	SoC1: Living in my neighborhood gives me a sense of community.		2.15 (0.55)
Membership	SoC2: I greet my neighbors who live on the same floor as me.		2.23 (0.75)
	SoC3: I get to know new friends in my neighborhood.		2.61 (0.89)
Shared emotional cohesion	SoC4: I chat casually with my neighbors.		2.35 (0.86)
	SoC5: My neighbors and I help each other.		2.80 (1.09)
Reinforcement	SoC6: My neighbors and I visit each other informally.		3.46 (1.26)
	SoC7: I know who to approach to make a change in my		2.72 (0.91)

	neighborhood.		
Influence	SoC8: My neighborhood will improve in the next five years.		2.26 (0.77)
	SoC9: I can make a change to my neighborhood.		2.78 (0.91)
Subjective walkability		Five-point Likert scale*	
Convenience			
Timesaving	SW1: The paths are efficient and timesaving.		2.11 (0.57)
Effort-saving	SW2: The paths are effort-saving.		2.04 (0.52)
Safety			
Traffic safety	SW3: I am not afraid of traffic accidents when walking in this neighborhood.		2.58 (0.98)
Crime Safety	SW4: I am not afraid of crime while walking in this neighborhood.		2.48 (0.83)
Security	SW5: The walking environment does not have enough lighting at night.		3.29 (0.83)
Aesthetics			
Air quality	SW6: The walking environment has a cleaner air quality/ less noise.		3.12 (1.02)
Landscape	SW7: The walking landscape is captivating.		3.08 (0.97)
Physical condition			
Cleanliness	SW8: The walking environment is clean.		2.52 (0.75)
Pavement condition	SW9: The path pavement is in good condition.		2.48 (0.70)
Facility			
Walk-friendly for disabled	SW10: The path is walk-friendly for people with disabilities.		2.58 (0.76)
Sitting furniture	SW11: The path has adequate sitting furniture		2.54 (0.81)
Comfort			
Path width	SW12: The walking paths are generally wide enough		3.22 (0.85)
Crowdedness	SW13: I find the walking paths crowded.		2.98 (0.70)
Overall	SW14: How satisfied do you feel walking in this neighborhood?		2.40 (0.63)

* Notes: Five-point Likert scale: strongly disagree = 1, somewhat disagree = 2, neutral = 3, somewhat agree = 4, and strongly agree = 5

The survey was conducted through face-to-face interviews, yielding 147 valid responses. Data collection took place between late December 2021 and early February 2022, during weekday evening peak hours (5 PM – 7 PM) to reach commuters who walk for both travel and leisure. Targeting commuters allowed us to capture respondents who experience varied walking conditions and purposes, providing a more comprehensive understanding of how walking habits relate to SW and SoC. This approach ensures the study reflects a broad spectrum of pedestrian experiences rather than focusing solely on leisure walkers. Respondents, all residents within a 500-meter radius of the magistracy building (**Figure 1**), were approached at different locations—either on footbridges or at-grade sidewalks—to ensure a diverse sample, even though many use both types of infrastructure. Of the total responses, 85 were collected from pedestrians on footbridges and 62 from those on at-grade sidewalks.

3.3 Generalized structural equation model

The Generalized Structural Equation Model (GSEM) extends the capabilities of Structural Equation Modeling (SEM) by addressing some of its key limitations. SEM is widely used to analyze complex relationships between variables, allowing researchers to explore direct, indirect, and total effects while addressing endogeneity issues (Golob, 2003; Loo and Tsoi, 2024). Its popularity stems from its flexibility in testing hypotheses involving intricate cause-and-effect relationships. However, traditional SEM assumes that all variables are continuous, even when some are categorical or ordinal (Kline, 2016). This assumption can lead to unrealistic interpretations. In this study, for example, SoC and SW are measured using five-point ordinal scales. Treating these variables as continuous in a conventional SEM framework could introduce biases in estimation and lead to misleading results. To overcome this limitation, this study employs GSEM, which integrates generalized linear modeling (GLM) techniques into SEM. Unlike traditional SEM, GSEM accommodates various data types, including continuous, binary, ordinal, count, and categorical variables. By incorporating GLM estimators (McCullagh and Nelder, 2019), GSEM enables maximum likelihood estimation using appropriate probability distributions, ensuring a more accurate and robust modeling approach. All estimations in this study were conducted using Stata SE17.

Another advantage of GSEM is its suitability for small sample sizes. Given the relatively modest sample size of 147 in this study, penalized likelihood methods were employed following Rosseel (2020) to enhance model estimation. In GSEM, indirect penalization is applied through shrinkage of path coefficients, which reduces model complexity and enhances generalizability. Instead of directly penalizing the structural equation estimates, the approach regularizes the entire likelihood estimation process, influencing regression paths by minimizing unnecessary relationships (e.g., $p < .1$), factor loadings by identifying key contributors to latent variables, and variance components by preventing overestimation in hierarchical or multilevel models. Unlike standard penalization in simple regression, indirect penalization in GSEM affects both the structural and measurement models. This method helps prevent overfitting by simplifying the model, enhances variable selection through Lasso regularization, improves multicollinearity handling using Ridge regularization, and facilitates estimation when the sample size is relatively small compared to model complexity.

Following Bentler (2007), this study also reports at least one a priori model that is expected to be rejected, a necessary step when using SEM with small samples. To assess the effectiveness of GSEM, a traditional SEM model was estimated for comparison. Model fit was evaluated using Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC), which are appropriate for likelihood-based estimation. While both SEM and GSEM can be applied to small samples under 200 (Hau and Marsh, 2004; Iacobucci, 2010; Tian and Yuan, 2019), caution is required when interpreting fit indices (Niemand and Mai, 2018). Unlike SEM, which provides traditional fit indices such as the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR), GSEM relies on likelihood-based estimation and does not produce these conventional fit measures. Instead, AIC and BIC are used to compare the goodness-of-fit of SEM and GSEM, following the approach of Yin et al. (2020). To further account for the small sample size, bootstrapping is applied, as recommended by Shrout and Bolger (2002)for psychology studies with sample sizes as small as 20 to 80 cases. Bootstrapping enhances the robustness of parameter estimates by generating multiple resampled datasets, ensuring more stable inference from limited data. By leveraging GSEM alongside penalized likelihood estimation and bootstrapping, this study provides a rigorous analytical framework that accounts for the ordinal nature of key variables, the small sample size, and the complexity of the relationships under investigation.

4. Results

4.1 Descriptive analysis

The t-test results in **Table 2** and box plot in **Figure 2** compare walking habits on footbridges versus sidewalks for both utility and leisure purposes. There is a statistically significant difference in the frequency of utility walking (e.g., commuting) between footbridges and sidewalks, with sidewalks being used more frequently. The large *t*-value (-9.346) and a *p*-

value of .000 indicate this difference is highly significant. Similarly, leisure walking is significantly less frequent on footbridges compared to sidewalks (t = -6.338 and p < .000). The duration of utility walking is significantly shorter on footbridges compared to sidewalks, with a large t-value (-15.390), highlighting a substantial difference. Leisure walking duration is also significantly shorter on footbridges than on sidewalks (t = -11.537). The results indicate that sidewalks are used more frequently and for longer durations than footbridges for both utility and leisure walking. This suggests that sidewalks play a more vital role in daily pedestrian activities and community life compared to footbridges, which are likely more focused on transportation rather than fostering social interaction.

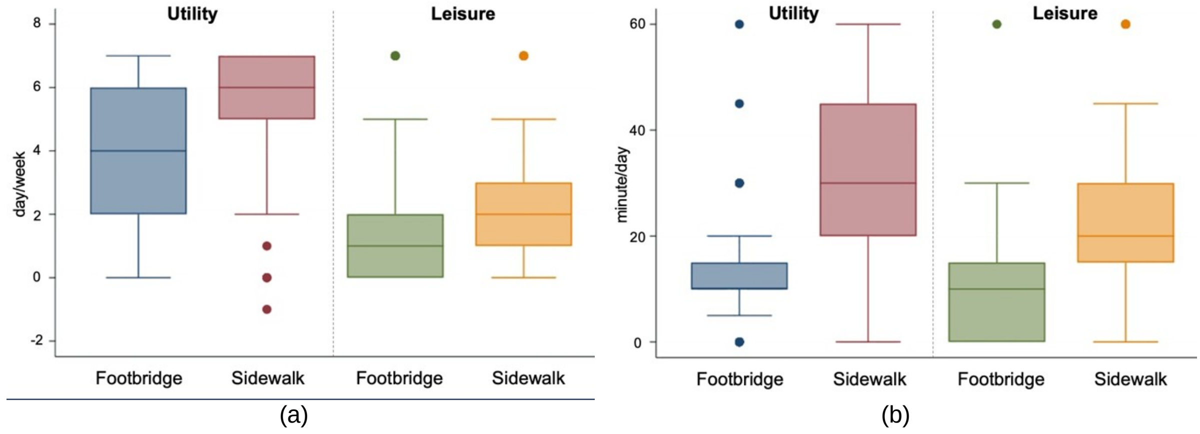

Figure 2 Box plot of (a) frequency and (b) duration of utility and leisure walking on footbridge and sidewalk

Table 2 t-test for difference of walking habits on footbridge and sidewalk

Variable	Mean (SD) Bridge	Sidewalk	Diff: Mean (SD)	t-value	p-value
Frequency					
Utility	3.97 (.19)	5.76 (.14)	-1.79 (.19)	-9.346	0.000
Leisure	1.59 (.17)	2.27 (.17)	-.673 (.11)	-6.338	0.000
Duration					
Utility	12.96 (.69)	31.22 (1.21)	-18.27 (1.19)	-15.390	0.000
Leisure	8.33 (.76)	22.18 (1.31)	-13.84 (1.20)	-11.537	0.000

4.2 Modelling results

Smaller values of the two goodness-of-fit measurements indicate a better fit. As summarized in **Table 3**, it is clear that the GSEM performed much better than the SEM considering the higher log-likelihood and lower values of AIC and BIC. The results indicate that the GSEM can better capture the relationships between socio-demographics, walking habit, SoC, and WS than the SEM.

Table 3 Comparison between GSEM and SEM

Model fit	GSEM	SEM
Log likelihood	-4085.45	-6425.329
AIC	8344.901	13024.66
BIC	8605.068	13284.82

4.2.1 Footbridges vs sidewalks

Table 4 presents the results of the GSEM, revealing a nuanced relationship between walking frequency, duration, and their effects on both SoC and SW. The findings highlight the distinct impacts of sidewalk and footbridge usage, underscoring the importance of distinguishing between leisurely and utilitarian walking activities when assessing their social and experiential outcomes.

Sidewalks are associated with higher walkability satisfaction and community ties. The frequency of leisurely walks on sidewalks is positively associated with SW, indicating that frequent leisurely walking correlates with enjoyment and satisfaction with the environment. However, it is negatively correlated with SoC, suggesting that while people may find these walks enjoyable, they do not necessarily foster a stronger sense of belonging within the community. This observation partially aligns with Clark and Scott (2013), who found that neighborhood social cohesion increases time spent walking, and Zhang et al. (2022), who identified a strong relationship between out-of-home activities in common neighborhoods and SoC. Notably, the duration of leisurely walks on sidewalks shows a significant positive effect on SoC, suggesting that longer but less frequent walks may foster deeper community connections, possibly due to more meaningful interactions occurring during extended periods. In contrast, utility walking on sidewalks appears to have a less favorable impact. Both the frequency and duration of utility walking negatively associated with SW and SoC, respectively. This suggests that walking driven by necessity—such as commuting or running errands—is less enjoyable and less conducive to building community ties. Unlike leisurely walking, which may encourage social interactions and engagement with the environment, utility walking often feels more obligatory, explaining its negative effects. These findings support Wood et al. (2010)'s argument that walking should be analyzed by trip purpose to fully understand its social implications, a perspective further reinforced by Deka and Brown (2020).

The findings also highlight the limitations of footbridges in fostering social connectivity and walkability. Frequent footbridge usage is significantly associated with lower SoC, suggesting that these elevated structures may hinder social interactions. Unlike sidewalks, which encourage casual encounters and a sense of place, footbridges elevate pedestrians above street-level activity, reducing opportunities for spontaneous social interactions that contribute to a stronger sense of belonging. The results also indicate that footbridge usage is negatively associated with perceived walkability, with the duration of footbridge use showing a significant negative relationship with SW. This may be due to the additional effort, detours, and inconvenience associated with footbridges compared to at-grade crossings, leading to a less favorable walking experience. Unlike footbridges, sidewalks integrate more seamlessly with public spaces and urban life, providing better access to amenities such as shops, parks, and seating areas that encourage engagement and interaction. The positive and significant relationship between sidewalk walking frequency and SW reinforces this point, suggesting that people who frequently use sidewalks perceive their environment as more pedestrian friendly. Additionally, the positive association between leisurely walking frequency on sidewalks and SW further highlights the benefits of sidewalks in creating a more inviting and socially engaging walking experience. Overall, these results underscore the importance of designing pedestrian infrastructure that enhances both walkability and social connectivity. While footbridges serve a functional role in improving pedestrian safety and mobility in areas with high vehicular traffic, they often come at the cost of social engagement and pedestrian convenience. Future urban planning efforts should consider incorporating features such as greenery, resting areas, and improved accessibility into footbridge designs to mitigate their isolating effects and enhance their contribution to a socially vibrant and walkable urban environment.

4.2.2 Socio-demographics

The results for the HKer variable reveal both direct and indirect effects on SoC and leisure walking frequency on sidewalks, highlighting its complex role in shaping pedestrian experiences. Self-identifying as a Hongkonger is significantly positively associated with SoC, suggesting that local residents report a stronger sense of community compared to non-local respondents. This may be attributed to deep-rooted social networks, long-term residency, and a shared cultural identity that fosters a sense of belonging despite the city's high population density and fast-paced urban lifestyle. The finding aligns with social capital theory, which suggests that strong community ties can be maintained even without frequent casual encounters, as established networks of trust and mutual support contribute to a strong SoC (Li et al., 2024). Additionally, Hong Kong's unique urban and social environment—where community relationships are often built through long-standing neighborhood ties rather than incidental street-level interactions—likely reinforces this pattern (Chan and Zhou, 2021). At the same time, HKer is significantly negatively associated with leisure walking frequency on sidewalks, indicating that local residents engage in less leisurely sidewalk walking compared to non-locals. This suggests that Hongkongers may rely more on other forms of social engagement outside of sidewalk leisure walking, potentially favoring indoor social venues, planned gatherings, or other settings better suited to their fast-paced and space-constrained urban lifestyle. Furthermore, HKer indirectly influences SoC through its impact on walking behavior. The results show that being a Hong Kong resident is associated with a higher frequency of utility walking trips, which is negatively associated with SoC. This implies that local residents primarily walk for practical purposes such as commuting or running errands, leaving less room for social interactions that contribute to a stronger community bond. However, despite engaging in less frequent leisure walking on sidewalks, Hongkongers still exhibit a strong SoC, suggesting that the depth and quality of social ties may be more influential than the frequency of interactions in shaping community cohesion. These findings underscore the importance of considering both walking purpose and cultural context when evaluating pedestrian behavior and its social outcomes. Efforts to enhance SoC in Hong Kong should focus not only on increasing leisure walking opportunities but also on designing public spaces that facilitate meaningful social engagement, particularly for residents whose pedestrian activities are primarily utilitarian.

Gender is significantly associated with both SoC and SW, providing insights that extend beyond walking habits alone. Males typically report a higher SoC, and greater SW compared to females, which could be attributed to several factors, including differing perceptions of safety, varying levels of social engagement, and cultural norms that shape their experiences in public spaces. For instance, men may feel more at ease in public areas to have social interaction (Jorgensen et al., 2013), which can naturally enhance their SoC. This sense of ease and engagement may be rooted in societal norms that encourage or facilitate male participation in public life (Hori and Kamo, 2018), potentially leading to stronger connections within their communities. On the other hand, women often face unique challenges that can negatively impact their SoC and SW. Research has shown that women are more likely to perceive certain areas, such as back alleys or poorly lit streets, as unsafe (Jiang et al., 2017). These perceptions of insecurity can deter women from engaging in the same level of social interaction in these spaces, thereby reducing their SoC. Additionally, concerns about safety may lead women to avoid certain walking routes or public spaces altogether, which can further diminish their overall walkability satisfaction. These gendered experiences highlight the need for urban planning and public policy to address safety and accessibility issues, ensuring that public spaces are welcoming and secure for all members of the community, regardless of gender.

Income also plays a crucial role in shaping the SoC, with higher-income individuals generally reporting a stronger SoC. This trend is not merely a reflection of income itself but suggests that other underlying factors, such as social capital and access to resources, significantly influence these outcomes (Schwanen et al., 2015). Higher-income individuals often possess stronger social networks and have better access to amenities (Rozynek and Lanzendorf, 2023), which facilitates more active participation in community activities and reinforces their SoC. However, the fact that income does not significantly affect walking habits indicates that these socioeconomic advantages are not necessarily tied to the frequency or duration of walking. Instead, they may be more related to the quality of interactions and opportunities that higher-income individuals can access. This points to a broader issue in the relationship between social and economic capital. DeFilippis (2001) argues that social capital is not independent of economic capital; it is often premised on the ability of certain groups to realize and leverage it, potentially at the expense of others. In this context, the stronger SoC among higher-income individuals may partly stem from their ability to utilize social capital more effectively, often through exclusive or higher-quality networks and resources. This highlights a potential inequity where the benefits of a strong SoC are more accessible to those with economic means, suggesting a need for policies that address these disparities to foster a more inclusive SoC.

The analysis also indicates that age does not significantly impact SoC or SW, likely due to the sample's focus on commuters. Commuters, regardless of age, often share similar routines —navigating the same transportation and pedestrian networks and following comparable work schedules—which homogenizes their walking experiences. Unlike leisure walkers, whose activities might vary widely across different age groups, commuters are primarily driven by practical needs, such as getting to and from work. This uniformity in purpose reduces the variability that age might otherwise introduce, making age a less significant factor in shaping SoC and SW within this commuter-focused sample. This finding suggests that for commuters, the shared experience of urban infrastructure plays a more decisive role than age in influencing one's SoC and SW.

Finally, our analysis reveals that the association between SoC and SW in Hong Kong is weaker than what has been reported in other studies, particularly those conducted in Western contexts such as the United States (Wood et al., 2010) and Australia (French et al., 2014). This discrepancy may be attributed to cultural and environmental differences between Hong Kong and these Western countries. The unique urban density, high-rise living, and the fast-paced lifestyle of Hong Kong residents may influence how community ties are formed and how walkability is perceived, making these relationships less pronounced. While Zhang et al. (2022) examined SoC within the Hong Kong context, their study focused on the elderly population and different types of neighborhoods, which differ significantly from the commuter-focused demographic in our study. Commuters have distinct routines and interactions with their environment, often prioritizing efficiency over social engagement, which could explain the weaker link between SoC and WS in this group. Additionally, the geographical differences in pedestrian network settings in Hong Kong play a crucial role. As

Xu et al. (2024) noted in their regional analysis of pedestrian networks, the infrastructure in different areas of Hong Kong varies significantly, potentially influencing how pedestrians experience and interact with their surroundings. This variation further complicates direct comparisons with studies conducted in more uniform or differently structured environments.

Table 4 Modelling results of GSEM[1]

From	**To**			
	Sidewalk		**SoC**	**WS**
	Frequency			
	Leisure	**Utility**		
Sidewalk				
Leisure				
Frequency			-.032***	.027*
Duration			.007***	
Utility				
Frequency			.022*	
Duration				-.003**
Footbridge				
Leisure				
Frequency			-.006**	
Duration				-.027*
Socio-demographics				
Male		.535*	.099**	.106***
Income			.114***	
HKer	-.688*		.105*	
Measurement				
SoC1			2.046***	
SoC2			1.500***	
SoC3			2.033***	
SoC4			2.17***	
SoC5			2.830***	
SoC6			2.800***	
SoC7			2.218***	
SoC8			1.518***	
SoC9			2.095***	
SW1				2.126***
SW2				.992***
SW3				2.922***
SW4				2.683***
SW5				.165*
SW6				3.078***
SW7				2.180***
SW8				3.332***
SW9				3.101***
SW10				2.775***
SW11				2.754***
SW12				1.209**
SW13				1.012**
SW14				2.254***

[1] Non-standardized effects

Note: *** $p < .01$; ** $p < .05$, * $p < .1$.

5. Discussion and conclusion

Sense of community encompasses both place-rootedness and social bonding (Long and Perkins, 2007; Zhang et al., 2022). This study examines how Tsuen Wan's footbridge network influences SoC by comparing walking experiences on footbridges and at-grade sidewalks, emphasizing how pedestrian infrastructure diversifies walking experiences within the same urban space. Our findings suggest that SoC is shaped not only by walking frequency and duration but also by the type of pedestrian infrastructure used. While prior research has focused on streets and transportation infrastructure as facilitators of mobility and accessibility (Guo et al., 2021), we highlight that pedestrian environments also play a crucial role in fostering or limiting social engagement. Physical separation in pedestrian infrastructure can result in social segregation in terms of SoC, extending beyond the studied effects of public transportation infrastructure (Loo et al., 2024). Streets are not merely passageways but vibrant public spaces where spontaneous interactions occur, contributing to a sense of belonging and community cohesion (Loo and Fan, 2023; Loo and Zhang, 2024).

Our findings indicate a potential trade-off in urban design: while Tsuen Wan's footbridge network enhances pedestrian mobility and connectivity (Xu et al., 2024), it does so at the cost of social interaction and community engagement. Footbridges facilitate efficient movement within the urban landscape, but they do not foster the same level of social bonding as sidewalks. The analysis reveals that while longer, leisurely walks on sidewalks are positively associated with SoC, frequent utilitarian walking—whether on footbridges or sidewalks—is associated with lower SW and SoC. This suggests that the efficiency provided by footbridges, which prioritize functional movement, may inadvertently reduce opportunities for the informal social interactions that are essential for community-building. These findings underscore the need for urban planning approaches that balance pedestrian mobility with the creation of spaces that encourage social engagement.

From a policy perspective, urban design must extend beyond mobility efficiency to consider the social implications of pedestrian infrastructure (Chan et al., 2024b). Given that frequent footbridge use is associated with lower SoC and SW among commuters, strategies should be implemented to mitigate their isolating effects for this group. Design interventions such as greenery, seating areas, and improved sightlines could make footbridges more inviting and socially engaging. Additionally, improving footbridge connectivity to sidewalks and fostering more pedestrian-friendly street-level environments can facilitate meaningful social interactions among commuters and reinforce community ties. Recognizing that different walking experiences—leisurely versus utilitarian—have varying social impacts for commuters, planning efforts should prioritize mixed-use pedestrian spaces that support both functional and recreational walking. In high-density cities like Hong Kong, where layered pedestrian networks are essential, urban design must not only enhance movement but also contribute to vibrant and cohesive communities.

While this study offers valuable insights into the relationship between pedestrian infrastructure, SoC, and SW, several limitations must be acknowledged. First, its cross-sectional design limits the ability to establish causal relationships. Individuals with a stronger SoC may be more likely to walk frequently rather than walking itself fostering SoC. Additionally, this study identifies statistical associations rather than causal mechanisms and does not directly capture how or why individuals use sidewalks and footbridges in ways that influence SoC and SW. Several potential confounding variables—such as personal mobility preferences, land-use diversity, and neighborhood social dynamics—may also shape these relationships. Future research should employ longitudinal or experimental approaches to clarify causality. Second, the study focuses on Tsuen Wan, a district with a highly developed footbridge network, which may limit the generalizability of findings to urban contexts with different pedestrian infrastructures and social dynamics. Third, the sample primarily consists of commuters, potentially introducing sampling bias. The exclusion of students, retirees, or other demographic groups raises questions about whether different populations experience walking environments and SoC similarly. Future research should incorporate a more diverse sample for broader applicability. Fourth, this study does not fully explore the interaction between footbridges and streets, particularly how their physical and functional connections influence pedestrian movement and social interactions. A deeper analysis of urban design strategies that enhance the synergy between these spaces would provide a more comprehensive understanding of pedestrian infrastructure's role in shaping SoC. Additionally, while we explore the relationship between pedestrian infrastructure and SoC, further qualitative research is needed to understand how transient and mobile experiences contribute to community-building. Future studies could employ ethnographic methods, in-depth interviews, or longitudinal designs to explore these dynamics more comprehensively, helping to establish causal links and providing a deeper understanding of how pedestrian spaces function as both physical and social environments. Finally, the study primarily relies on self-reported measures, which, while valuable for capturing subjective experiences, may be affected by recall bias or individual differences in perception. Future research could integrate observational data or GPS tracking to provide a more comprehensive understanding of pedestrian experiences and social interactions in urban spaces.

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