Jurnal Kejuruteraan 38(1) 2026: 275-287
https://doi.org/10.17576/jkukm-2026-38(1)-25

The Role of Sense of Place in Enhancing Environmental Sustainability: A Case Study of the Waterfront in Jinan, China

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Received 1 April 2025, Received in revised form 29 September 2025
Accepted 29 October 2025, Available online 30 January 2026

ABSTRACT

Urban waterfronts are increasingly recognized for their potential to integrate environmental, social, and cultural values, making them essential for sustainable development. While many studies have focused on technical solutions to improve sustainability, few have addressed the significance of the sense of place in fostering environmental stewardship in waterfront areas. This research aims to explore how the sense of place, encompassing cognitive, affective, and behavioral aspects, contributes to environmental sustainability in urban waterfronts. A mixed-methods approach was adopted. Quantitative data were collected through a convenience sampling questionnaire survey of waterfront users (n = 326) to identify significant indicators of the sense of place. Additionally, qualitative insights were obtained from semi-structured interviews with 12 frequent waterfront users to understand how the meanings associated with a place influence sustainable behaviors. The results highlight eight crucial factors that strengthen the sense of place and promote environmental sustainability: 1) attractive landmarks or focal points, 2) regional characteristics that create narrative landscapes, 3) well-maintained surroundings, 4) community events, 5) welcoming public spaces, 6) conservation of cultural and historical heritage, 7) participatory activities, and 8) informative signboards. This study provides urban designers, waterfront developers, and policymakers with a theoretical framework for developing urban waterfronts that enhance community attachment and encourage sustainable practices. It also delivers valuable insights for promoting sustainability in underdeveloped or rural waterfront regions.

Keywords: Urban waterfront; sense of place; environmental sustainability; Partial Least Squares Structural Equation Modeling (PLS-SEM)

INTRODUCTION

Urban waterfronts serve as important elements in urban environments by integrating natural, environmental, economic, and cultural values into public life (Ying et al. 2023). Historically, many early civilizations developed along waterways, which imparted both ecological and cultural significance to these waterfronts (Ehsan et al. 2024). These areas present unique opportunities to enhance environmental sustainability, particularly through community engagement. When local communities actively participate in the design, maintenance, and utilization of waterfronts, they are more likely to cultivate a sense of ownership and responsibility. This engagement can lead to pro-environmental behaviors, such as waste reduction, conservation efforts, and support for ecological restoration initiatives (Rehan 2024; Weng 2010). Furthermore, the environmental and social benefits of well-managed waterfronts contribute to broader objectives of sustainable urban development. They address contemporary urban

challenges, including climate change, biodiversity loss, and declining community well-being, by promoting green infrastructure, preserving natural habitats, and creating inclusive, resilient public spaces (Wiegleb et al. 2017).

While extensive research has examined technical solutions for enhancing the environmental sustainability of urban waterfronts, such as wastewater treatment and pollution control (Daud et al. 2024; Tebal 2022), less attention has been paid to the socio-cultural dimension, particularly the role of sense of place. Sense of place, which encompasses emotional attachment, identity, and meaning associated with a location, has increasingly been recognized as a critical factor in fostering environmental stewardship and promoting sustainable behavior (Kuo et al. 2021). Therefore, it is essential to explore how the sense of place can contribute to sustainability in urban waterfronts by shaping pro-environmental attitudes and behaviors within communities.

This study aims to explore how the sense of place contributes to environmental sustainability in urban waterfronts. Three main dimensions of sense of place: cognitive, affective, and behavioral, will be measured to identify key indicators that encourage sustainable practices.

The innovation of this study is twofold. First, it explores the relationship between sense of place and environmental sustainability, a connection that has received limited attention in existing research. Second, it specifically applies the concept of sense of place to urban waterfronts, highlighting how their unique spatial, cultural, and ecological characteristics can foster place attachment and, in turn, support sustainable urban development. This study provides urban designers, waterfront developers, and policymakers with a theoretical framework for developing urban waterfronts that enhance community attachment and encourage sustainable practices. Additionally, it offers valuable insights for promoting sustainability in underdeveloped or rural waterfront regions.

This paper is organized into six sections. The first section introduces the research background and objectives. The second section presents a literature review, providing a concise discussion of key concepts: environmental sustainability, sense of place, and urban waterfronts. The third section outlines the research design and case study context. The fourth section presents the results from both quantitative and qualitative analyses. The fifth section discusses the main findings and their implications. The final section concludes the paper with a summary of the key contributions.

LITERATURE REVIEW

The objective of this study is to investigate how the sense of place contributes to environmental sustainability in urban waterfronts. Accordingly, this section provides a brief overview of the key concepts central to this research: environmental sustainability, sense of place, and urban waterfronts.

ENVIRONMENTAL SUSTAINABILITY

Environmental sustainability can be defined as the maintenance of conditions that support the long-term coexistence of humans and nature while balancing the ecological, social, and economic needs of urban systems (Abdulwahhab Khalaf et al. 2023; Basiago 1998). It involves practices that preserve ecological health, protect biodiversity, and promote the sustainable use of natural resources (Shuhaimia et al. 2022). In the context of urban development, environmental sustainability has become a central concern as cities face increasing pressures from population growth, climate change, and environmental degradation (Kang et al. 2019).

Recent research highlights the essential role of land-use planning and green-blue infrastructure, such as parks, urban forests, rivers, and waterfronts, in achieving environmental sustainability These elements not only provide vital ecosystem services, including air and water purification, flood control, and temperature regulation, but also enhance urban resilience and overall quality of life. For instance, waterfront areas, with their unique ecological functions and aesthetic appeal, significantly contribute to the ecological health and livability of urban environments (Nag et al. 2025). Furthermore, targeted waterfront planning policies often incorporate environmental objectives, such as habitat restoration and public access to water, positioning waterfronts as crucial components of sustainable urban development (Ragheb et al. 2024).

Most current studies on environmental sustainability focus on measurable indicators, such as air and water quality, carbon emissions, and land-use efficiency (Gumelar et al. 2017; Raman et al. 2023). However, these approaches often emphasize technical or quantitative measures, frequently overlooking the influence of human experience, perception, and cultural values. Increasingly, scholars argue that social dimensions, such as community engagement, place attachment, and cultural identity, are integral to shaping sustainable environmental behavior and outcomes (Collins et al. 2022; Hernandez Gonzalez 2023). This suggests that environmental sustainability is not only an ecological or infrastructural concern but also a deeply place-based and socio-cultural process. In this context,

people's relationships with and interactions with the environment enhance sustainability interventions by fostering a stronger sense of responsibility and long-term stewardship of place.

SENSE OF PLACE AS AN INDICATOR

Researchers have conceptualized the sense of place as a general attitude regarding users' perceptions and emotional responses to their environment (Counted 2019; Mohammad-Moradi et al. 2020). In recent years, scholars have sought to expand this understanding by examining the sense of place from various ontological and epistemological perspectives to better explain behavior (Davis & Wagner 2024; Zhang et al. 2019). The sense of place is no longer viewed as a static emotional state; rather, it is recognized as a dynamic, multidimensional construct that both influences and is influenced by individuals' experiences and intentions within a specific setting.

In the context of urban waterfronts, the sense of place plays a particularly vital role due to the unique ecological, cultural, and social characteristics of these environments. Scholars have begun to emphasize that strengthening individuals' connections to waterfronts can be a strategic approach to promoting environmental sustainability. When people feel a strong bond with a place, they are more likely to support environmental conservation, adopt pro-environmental behaviors, and actively participate in the stewardship of public spaces (Abdulwahhab Khalaf et al. 2023; Zhang & Tokuhisa 2015). Therefore, the sense of place can serve as an indicator of how effectively a community engages with sustainability practices.

Building on this conceptual foundation, Latip et al. (2023) categorized the sense of place into three dimensions: cognitive, affective, and behavioral.

The cognitive dimension relates to how individuals perceive and value a place. Chamlee-Wright and Storr (2009) emphasized that each location presents a unique combination of characteristics that, when experienced collectively, fosters a sense of place that is inherently irreplaceable. In this context, Christiaanse and Haartsen (2020) discovered that when a specific site becomes the spatial or symbolic core of an individual's daily life, it assumes an indispensable role in the development of place identity. Furthermore, Brocato et al. (2015) introduced the concept of continuity as a temporal construct, wherein places become woven into the life trajectories of individuals through personal events and rituals over time. These insights indicate that cognition reflects the mental recognition of the waterfront's uniqueness, importance, and its connection to personal or collective memories.

The affective dimension emphasizes the emotional attachment that individuals form with waterfront areas. Brocato et al. (2015) defined nostalgia as a subset of autobiographical memory that links people to places and deepens emotional bonds. In Lim and Barton's (2010) study, a participant involved in the creation of a community mural expressed a strong sense of pride and ownership, indicating that direct engagement with a location can generate enduring emotional attachment. Similarly, Silver and Grek-Martin (2015) reported that residents experienced feelings of sadness, devastation, or even depression following the loss of valued aesthetic features in their neighborhood, illustrating how emotional ties can be disrupted when a place's character is altered. In summary, these studies demonstrate that the affective dimension of the sense of place encompasses feelings of nostalgia, pride, and happiness associated with spending time in the waterfronts.

The behavioral dimension involves the actions and behaviors that demonstrate individuals' commitment to a particular place. Eisenhart et al. (2019) observed that people's attachment often arises from comparing their current environment with past experiences, which reinforces their preference for and loyalty to specific locations. In Qian et al.'s (2021) study of the devastated Beichuan County town, behaviors such as revisiting and protecting the site exemplified a form of behavioral exclusivity, where the place held greater significance than alternatives. In this sense, the behavioral dimension includes the willingness to spend time in the area, a sense of responsibility for its preservation, and the intention to return.

These dimensions and their respective indicators highlight how the sense of place can influence behaviors and attitudes toward the environment (Table 1).

TABLE 1. Indicators of the sense of place within urban waterfronts

Dimensions	Survey items	Code
Cognitive	This place is very unique to me.	CG1
	This place is very important to me.	CG2
	This place carries my personal memories.	CG3
	This place carries the historical memories of old Jinan city.	CG4
Affective	I will miss this place if I need to leave here.	AF1
	I am proud to have this place.	AF2
	I feel happy when I spend time here.	AF3
Behavioral	I spend more time here than in other places.	BH1
	I am responsible for protecting this place from damage.	BH2
	I will visit this place again.	BH3

URBAN WATERFRONT AS A PLACE

Urban waterfronts are defined as "an area where water and land meet" (Üzümcüoğlu & Polay 2022, p. 3). These spaces are more than physical edges; they are culturally and emotionally significant places shaped by centuries of residential, commercial, and industrial use (Ying et al. 2023). This layered history fosters a strong sense of place, as waterfronts often embody the identity, memory, and everyday life of the communities they serve.

As cities evolve, waterfronts have increasingly emerged as symbolic anchors of urban identity and continuity, playing a central role in regeneration efforts and sustainable development agendas (Park & Ha 2012). Their unique combination of natural and built environments contributes to their distinct character, while their ecological functions, such as water purification, flood regulation, and biodiversity support, reinforce their value to both people and ecosystems (Stangl et al. 2022).

Furthermore, well-designed waterfronts strengthen the human-nature relationship by providing accessible public spaces that encourage walking, cycling, and environmental interaction (Zhang & Tokuhisa 2015). These qualities not only help reduce urban sprawl and reliance on motorized transport but also promote environmental awareness and community stewardship. These suggest that urban waterfronts are essential to environmental sustainability and central to cultivating a lasting sense of place.

METHODOLOGY

CASE STUDY

The waterfront in Jinan City, China, was selected for this study due to its distinctive topography, which contributes to a rich sense of place (Sun & Zhao 2018). The area is characterized by a significant number of natural springs and historical landscapes concentrated in the urban areas, making it a focal point for both residents and visitors (Wu & Ma 2024). Therefore, Jinan waterfront serves as an important site for exploring how a sense of place can inspire community responsibility toward sustainable practices. Following Han's (2025) definition, the scope of the waterfront is defined by both natural and man-made boundaries, as shown in Figure 1.

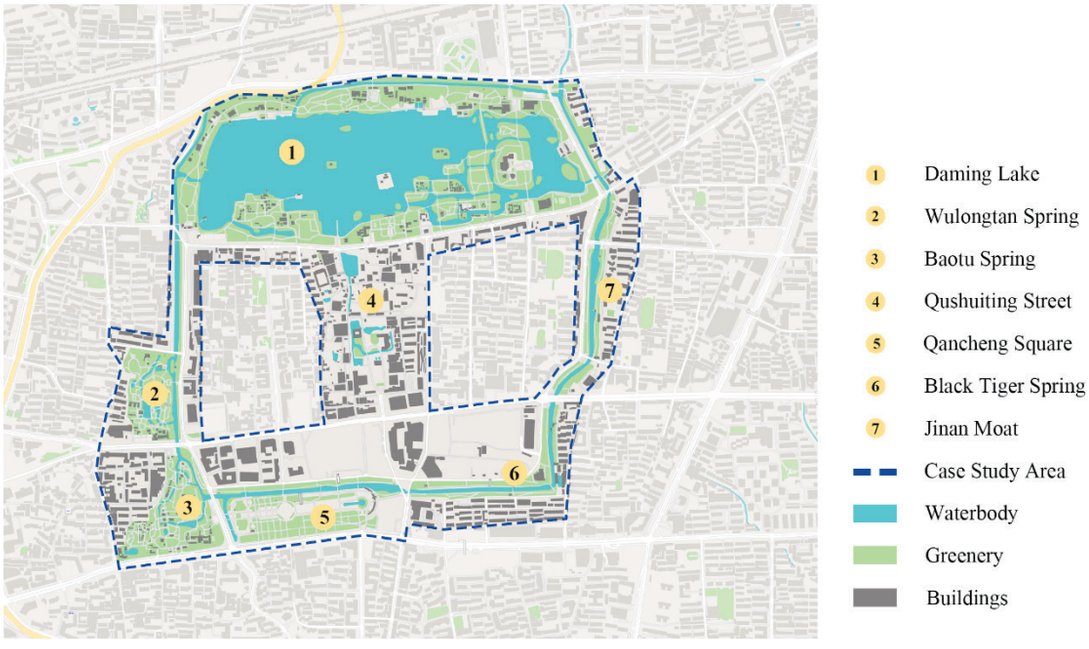

FIGURE 1. Location map and significant sites of the case study area

RESEARCH DESIGN

This study employed a mixed-methods approach to explore the sense of place in urban waterfronts. A questionnaire survey was conducted using convenience sampling, targeting those who actively use the waterfront in Jinan. The questionnaire items were designed based on previously established indicators of sense of place, aiming to capture users' cognitive, affective, and behavioral responses to the environment. Prior to participation, all respondents were provided with an informed consent form to ensure ethical compliance. The design of the questionnaire was reviewed and approved by academic supervisors and the affiliated

institution. A pilot study was conducted before the main survey to ensure the clarity, reliability, and relevance of the questions.

The required sample size was calculated based on a 95% confidence level with a 5.5% sampling error, resulting in a minimum of 317 respondents (Vaus 2002). A total of 326 valid responses were collected, exceeding the threshold and thereby enhancing the robustness of the quantitative analysis. The survey data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine the relationships between the sense of place and its dimensions (Hair et al. 2022; Mohammed Yousaf et al. 2023).

To complement the quantitative findings, semi-structured interviews (n = 12) were conducted and analyzed thematically to uncover deeper insights into the emotional and social meanings that respondents associate with the waterfront. The interviews followed the same core questions outlined in Table 1 but allowed for open-ended elaboration. The sample size was determined by data saturation, which typically ranges from 9 to 17 participants in qualitative research (Boakye & Akpor 2012; Hennink & Kaiser 2022). The thematic analysis involved initial coding, category development, and theme refinement to ensure internal consistency and meaningful interpretation of the qualitative data. This triangulation of methods provided a comprehensive understanding of the sense of place as experienced by waterfront users, which further enhancing the sustainable practices in the urban waterfront.

DEMOGRAPHIC BACKGROUND

A total of 326 responses were collected through the questionnaire survey, while 12 participants were involved in the interviews. The demographic profile of respondents is summarized across three categories: age, gender, and user roles (Table 2).

TABLE 2. Demographic background of the participants

User groups		Questionnaire	Interview
Age	19-34	84	4
	35-49	96	3
	50-64	93	4
	65+	53	1
Gender	Male	163	6
	Female	163	6
User roles	Visitor	88	2
	1-10 years	48	3
	10-20 years	44	3
	20+ years	146	4
In total		326	12

The questionnaire respondents represented a wide range of age groups and usage durations, with a balanced gender distribution. In terms of age, 84 were aged 19-34, 96 were aged 35-49, 93 were aged 50-64, and 53 were aged 65 and above. The gender split was equal, with 163 males and 163 females. For user roles, based on the number of years using the waterfront, 88 respondents identified as visitors, 48 had used the waterfront for 1-10 years, 44 for 10-20 years, and 146 for more than 20 years.

The interview group also included a range of ages and waterfront use histories. Among them, 4 were aged 19-34, 3 were aged 35-49, 4 were aged 50-64, and 1 was aged 65 or older. The gender distribution was balanced, with 6 males and 6 females. In terms of user roles, 2 participants were visitors, while 3 had used the waterfront for 1-10 years, 3 for 10-20 years, and 4 for over 20 years.

Overall, the distribution of participants was representative across all categories, closely aligning with the demographic patterns reported in previous studies of the same area (Du 2022; Zhang 2022). This ensures both the validity and representativeness of the data, providing a solid foundation for the subsequent analysis.

RESULTS AND DISCUSSIONS

This section presents the findings from both quantitative and qualitative approaches employed in this study, exploring the sense of place within Jinan waterfronts.

QUANTITATIVE FINDINGS

The quantitative analysis used the PLS-SEM technique through SmartPLS software (Figure 2). The data were collected from 326 waterfront users in Jinan City to determine the significant items that contribute to the sense of place (cognitive, affective, and behavioral) in the waterfront.

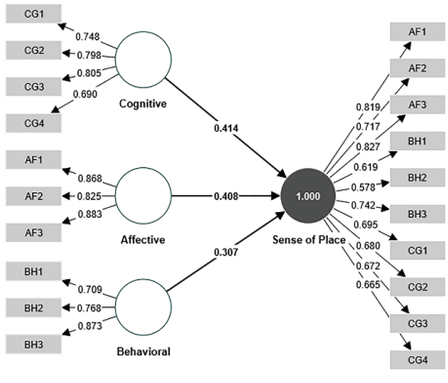

FIGURE 2. Factor loadings and path coefficients of the construct model

As shown in Table 3, the model was evaluated for reliability and validity based on several metrics: factor loadings, Cronbach's alpha (α), Composite Reliability (CR), and Average Variance Extracted (AVE). The results show satisfactory characteristics, with all the factor loadings above 0.6. However, although one of them is below 0.7, it is considered acceptable if the AVE > 0.5 (dos Santos & Cirillo 2023). Additionally, all measured metrics of the cognitive (α = 0.757, CR = 0.846, AVE = 0.580), affective (α = 0.822, CR = 0.894, AVE = 0.737), and behavioral (α = 0.687, CR = 0.828, AVE = 0.618) dimensions exceeded or approached the acceptable threshold, with α values above 0.6 (Thanh et al. 2022), CR values above 0.7, and AVE values above 0.5 (Hair et al. 2022). This indicates that they are reliable and valid indicators of sense of place in the Jinan waterfront.

TABLE 3. Reliability and validity for the sense of place

Dimensions	Items	Factor loadings	α	CR	AVE
Cognitive	CG1	0.748	0.757	0.846	0.580
	CG2	0.798			
	CG3	0.805			
	CG4	0.690			
Affective	AF1	0.868	0.822	0.894	0.737
	AF2	0.825			
	AF3	0.883			
Behavioral	BH1	0.709	0.687	0.828	0.618
	BH2	0.768			
	BH3	0.873			

Table 4 presents the significance of the sense of place dimensions through Variance Inflation Factor (VIF), path coefficient (β), t-value, and p-value. The results indicated strong relationships between all three dimensions (cognitive, affective, and behavioral) and the sense of place.

TABLE 4. Significance in the relationship of the sense of place

Relationships	VIF	β	t-value	p-value
Cognitive -> Sense of Place	2.202	0.414	26.638	0.000
Affective -> Sense of Place	2.703	0.408	31.972	0.000
Behavioral -> Sense of Place	1.930	0.307	22.665	0.000
*** p < 0.01 (t > 2.57), ** p < 0.05 (t > 1.96), * p < 0.1				

The analysis revealed that the cognitive dimension had the strongest effect on the overall sense of place (β = 0.414, t = 26.638, p = 0.000). Followed by the affective dimension, which also demonstrated a substantial influence (β = 0.408, t = 31.972, p = 0.000). The behavioral dimension showed a positive but comparatively weaker effect compared to other dimensions (β = 0.307, t = 22.665, p = 0.000). This indicates that all dimensions are significant to predict the sense of place of the waterfront in Jinan City (Hair et al. 2022).

In short, the quantitative analysis confirms that all proposed indicators and dimensions are reliable and valid contributors and predictors of the sense of place within the urban waterfront in Jinan City.

QUALITATIVE FINDINGS

The thematic analysis of interviews was based on the items assessed in the quantitative analysis, with three main themes: cognitive recognition, emotional attachment, and behavioral engagement. These dimensions are key indicators in understanding how the sense of place of the waterfront fosters sustainable practices.

COGNITIVE

The cognitive dimension involves the recognition of the uniqueness, importance, and past individual and historical memory of the urban waterfront. Interviewees commonly expressed the personal and cultural value to them due to its distinctive topography:

"I heard from the guide that the springs in Jinan are all underground water, and the temperature is always more than 10 degrees, so I was very surprised to see steam rising from the water in winter. This was the first time I had seen such a scene. When I put my hand in, I found the water to be quite warm." (Interviewee 4)

The excerpt above shows that the unique topography of Jinan's springs attracts the attention of temporary tourists, enhancing their appreciation and interactions with the local environment. It is believed that this heightened awareness can inspire citizen engagement in the preservation of the beauty and uniqueness of the waterfront (Opoku et al. 2024).

Meanwhile, a total of nine respondents emphasized the importance of the Jinan waterfront in their daily lives, while the remaining three were tourists or short-term residents. They believe that the Jinan waterfront holds greater importance for locals, as for them, *"it's just for fun" (Interviewee 5)*.

"Of course, it is important. This is the soul of Jinan." (Interviewee 7)

"It can be said that there would be no Jinan without its springs. As a native of Jinan, I feel a responsibility to preserve and promote the city's spring culture. Additionally, I hope that the younger generation of Jinan will share this culture with the world, allowing more people to appreciate it and encouraging greater participation in the protection of our springs." (Interviewee 12)

As noted by several local residents, the waterfront is considered the *"soul of Jinan,"* indicating that its natural features become an integral part of the city's identity. This intergenerational responsibility is believed to foster sustainable practices that prioritize long-term ecological balance (Law 2019).

As for memories, the most impressive memories shared by six respondents were related to their interactions with the water, including fetching water, drinking tea, and washing clothes. Three individuals mentioned aquatic creatures, such as geese, carp, and water plants.

"... fetch water from here to drink... the water is so clear that I can see the plants at the bottom... I chat with the grandpas and grandmas there, they said they had been drinking the water here since they were young... It's good to have such a place in the city." (Interviewee 1)

The quotation illustrates how the recollection of clear, drinkable water fosters awareness and commitment. These collective experiences not only reinforce cultural connections but also motivate responsible resource management (Ardoin et al. 2023).

Historical memory, including poetry, notable figures, and monuments, plays a vital role in influencing sustainable actions, particularly by fostering a sense of identity and continuity. As one interviewee stated:

"As a native of Jinan, I feel very proud that my hometown has produced so many great people." (Interviewee 9)

It is evident that a rich cultural memory develops a sense of ownership, motivating people to protect their shared cultural and historical legacy (Srinivas 2025).

In short, cognitive recognition of the Jinan waterfront that can influence environmental sustainability may be enhanced by: the unique formation of spring water that enhances appreciation and engagement; narrative landscapes that are integrated into the city's identity; maintenance that fosters awareness and commitment; and active activities that engaged the community with the waterfront.

AFFECTIVE

The affective dimension contains the feeling of nostalgia, pride, and happiness experienced while spending time at the urban waterfront. The sense of nostalgia significantly enhances emotional attachment to a place, which, in turn, serves as a motivator to connect the individual with the urban waterfront. One interviewee (7) reflects on the slow-paced lifestyle and the close relationships in the area, saying, *"I don't want to leave here because I feel that the relationships between people here are close... If we meet on the road, we will say hello to each other even if we don't know each other. This kind of environment is not easy to come by."* Such emotional bonds increase the likelihood that users will take responsibility to cherish and maintain the environment (Hall & Kawall 2021).

"Whenever I see a tour guide leading people in our place, I feel a sense of pride... I get really angry when outsiders say that the spring water in Jinan is artificial." (Interviewee 8)

Pride, as illustrated in the quotation, is closely linked to personal and collective identity, and an acknowledgment of the unique place qualities. As supported by Hall (2021), the feeling of pride serves as a catalyst that transforms passive appreciation into active engagement.

However, when discussing the sense of happiness, some of the respondents expressed opposing views, as outlined below:

"... it has been commercialized, and there are no Jinan characteristics. The houses are all newly built, not the traditional ones. This blend of neither modern nor traditional makes me uncomfortable." (Interviewee 2)

"... nothing is interesting. There may be cultural heritage, but nothing stands out." (Interviewee 3)

It is believed that when individuals experience positive emotions, they are more likely to develop an emotional attachment to the space (Brocato et al. 2015). However,

the opposite is also true when individuals feel dissatisfaction or disconnection from the place. As highlighted by the respondents, negative feelings toward the commercialization and lack of traditional characteristics can erode the sense of place. This further illustrates that a lack of happiness and emotional fulfillment can undermine feelings of ownership and responsibility.

In short, environmental sustainability can be improved through a sense of ownership and responsibility generated from the welcoming atmosphere of public spaces, the distinctive characteristics, as well as the conservation of traditional and heritage sites in the historic city of Jinan.

BEHAVIORAL

The behavioral dimension reflects the actions individuals take due to their connection to the urban waterfront. When discussing the time they spend at the waterfront, most of the respondents expressed their enthusiasm for this place and attempted to compare it with other places.

"The water (in other cities) usually comes from rivers or seas, which are very wide and inaccessible. In contrast, the springs in Jinan are narrow and intimate, closely integrated into daily life... These springs flow alongside the streets, allowing visitors to enjoy the scenery while exploring local shops, eating traditional snacks, and entering nearby houses to experience local customs." (Interviewee 11)

Frequent visits may encourage social engagement and interactions, creating a collective identity among users (Leap & Thompson 2018).

This sentiment is also evident in people's awareness of their responsibilities. While many respondents expressed that it is *"everyone's obligation" (Interviewee 9)* to *"protect water resources from pollution and to protect the heritage from destruction" (Interviewee 10)*, a larger number expressed their pity over the historical sites (city walls, old houses) that had been demolished. When community members articulate their responsibilities toward protecting water resources and historical sites, they are also likely to advocate for stronger regulations, leading to legislation that prioritizes sustainability and heritage conservation (Anderson et al. 2017).

Moreover, all interviewees expressed their determination to remain in Jinan or to visit again. Some said it was because of work or family, while others mentioned that they *"enjoy life here"* and felt *"very happy living in this city."*

In short, behavioral engagement in Jinan waterfront can enhance environmental sustainability with the following aspects: participatory activities, conservation of monuments, and responsibility education.

To sum up, as validated by the interview results, all contributors and predictors to the sense of place are significant to enhance the sustainable practices within the urban waterfront. Environmental sustainability can benefit from:

1. Cognitive recognition: through attractive and narrative landscape, maintenance, and active activities that foster community engagement and commitment;
2. Affective attachment: through a welcoming atmosphere, distinctive quality of a place, and heritage conservation that enhance a sense of ownership and responsibility;
3. Behavioral intention: through participatory activities, conservation, and educational information that encourage a sense of responsibility.

DISCUSSIONS

This study aims to explore how the sense of place contributes to environmental sustainability in urban waterfronts. Three main dimensions of sense of place: cognitive, affective, and behavioral, are measured to identify key indicators that encourage sustainable practices. Quantitative analysis using PLS-SEM confirms that the proposed indicators within each dimension are reliable and valid contributors to the overall sense of place in Jinan's urban waterfront. The qualitative interview findings further validate these results, emphasizing the importance of spatial and social qualities in promoting user connection to place and commitment to sustainability.

Cognitive recognition is closely linked to how individuals mentally process and evaluate their environment (Jorgensen & Stedman 2001). According to the findings, spatial qualities such as narrative landscapes, consistent maintenance, and vibrant surroundings enhance this mental engagement, enabling users to associate the space with clarity, identity, and significance. Narrative landscapes, particularly those that incorporate symbolic features, cultural references, and place-based stories, strengthen the mental image of a space (Abdulwahab et al. 2025). As noted by Shamsuddin and Ujang (2008), mature trees and vernacular residential forms contribute to a street's unique character, enhancing users' ability to cognitively distinguish it from other locations. When public spaces are designed to reflect local identity and history, users are more likely to recognize them as valuable and irreplaceable.

Maintenance is another key factor. Jacobs (1993) emphasized that individuals naturally gravitate toward

clean, well-maintained environments. Physical upkeep indicates that a place is respected and cared for, which enhances cognitive assessments of safety, quality, and community value (Nasrudin et al. 2018). When users perceive that a space is intentionally maintained, it fosters a sense of shared responsibility and encourages stewardship (Choy et al. 2024).

In addition, vibrant spaces that offer diverse activities enhance cognitive recognition by fostering familiarity and engagement (Francis et al. 2012). Shamsuddin and Ujang (2008) discovered that respondents were more inclined to appreciate spaces that facilitated people-watching and street vending, as these features contributed to a lively atmosphere and social vitality. Frequent exposure to such environments enables users to incorporate the place into their mental and emotional routines, thereby reinforcing its distinctiveness in their daily lives.

Affective attachment refers to the emotional connections individuals develop with a place, often influenced by its atmosphere, aesthetics, and cultural significance (Scannell & Gifford 2010; Ujang 2017). This study identified several qualities that promote emotional bonds, including a welcoming atmosphere, distinctive spatial character, and visible efforts in heritage conservation. Active and socially dynamic environments, where daily activities such as vending, walking, and gathering are both visible and palpable, generate a sense of liveliness and emotional warmth (Kusumowidagdo et al. 2023). This atmosphere can cultivate a sense of intimacy with the space, enhancing users' feelings of familiarity and comfort, which are essential to place attachment (Nugroho & Zhang 2022).

Equally important is the presence of a distinctive spatial character, particularly one that reflects local identity and cultural patterns. When users perceive a place as unique, whether through traditional architecture, local art, or everyday activities, they are more likely to form positive emotional associations with it (Ying et al. 2023). Prior research has demonstrated that users express a strong preference for environments that maintain a recognizable identity over time, especially when such spaces preserve their cultural integrity through design and use (Hussein et al. 2020).

Heritage conservation and adaptive reuse further strengthen emotional connections by linking the past with the present. Spaces that preserve historic elements while continuing to meet community needs are often regarded as both meaningful and relevant (Ibrahim et al. 2018). Users tend to appreciate environments where old buildings are maintained not merely as monuments but as active components of urban life (Pérez-Ramírez et al. 2019). This continuity of use and symbolism fosters feelings of pride and emotional investment (Nugroho & Zhang 2022).

The behavioral dimension reflects both actual and intended actions that support a place (Kudryavtsev et al. 2012). In Jinan's waterfront, participatory activities, conservation practices, and the availability of educational signage or programs emerged as influential elements that drive behavior. Participatory activities integrated into daily routines, such as gathering, strolling, or engaging in small-scale consumption, often serve as the initial step in anchoring behavior to a specific location (Nasrudin et al. 2018). As observed in Lim's (2010) study, simple repeated actions, such as visiting a familiar shop or meeting acquaintances, can gradually evolve into a network of social relationships rooted in the physical setting.

Conservation practices are further enhanced when spaces maintain and highlight their unique character. In urban environments where the adaptive reuse of historic buildings is evident, users often express appreciation not only for their aesthetics but also for their functionality. According to Nugroho and Zhang (2022), users value heritage buildings that remain in active use, recognizing them as positive examples of blending preservation with everyday life. This sense of continuity not only strengthens place loyalty but also fosters a protective attitude toward the built environment (Salim & Mohamed 2018).

Educational elements, such as plaques, monuments, and interpretive signage, can significantly influence behavior by increasing awareness. When spatial narratives are made accessible, through printed text or storytelling features, users are better equipped to recognize the cultural or ecological significance of a place (Audin 2021). In the study conducted by Nugroho and Zhang (2022), the visibility of these elements enabled participants to connect with the identity of the location, thereby reinforcing a sense of responsibility and behavioral exclusivity.

Collectively, the sense of place, including cognitive, affective, and behavioral, forms an interrelated and comprehensive framework through which individuals develop attachment, awareness, and responsibility. These elements are essential foundations for promoting environmental stewardship in urban waterfront contexts.

CONCLUSIONS

To conclude, this study demonstrates how a strong sense of place (cognitive, affective, and behavioral) can promote environmental sustainability in urban waterfronts. The findings reveal ten indicators that can measure and predict the sense of place, which contribute significantly to sustainable behaviors and practices. This suggests that the sense of place in the urban waterfronts can serve as an efficient tool to promote environmental stewardship and long-term ecological balance.

Urban designers and policymakers can contribute to the framework to develop an urban waterfront that enhances cognitive recognition, emotional attachment, and behavioral engagement through the following aspects:

1. Visually appealing landmarks or focal points to enhance the waterfront experience;
2. Regional characteristics (animals, plants, and monuments) to create a narrative landscape;
3. Well-maintained physical environments to promote user enjoyment and awareness;
4. Community events to encourage social cohesion and collective stewardship;
5. Welcoming public spaces to enhance social interactions;
6. Conservation of cultural and historical sites to preserve the city's identity;
7. Participatory activities to generate a sense of ownership;
8. Informative signs to stimulate reflection.

These elements have been shown to have a significant impact on community attachment and sustainable practices. By integrating these design approaches into the policies and guidelines, urban waterfronts can be transformed into significant hubs that not only provide recreational functions but also foster environmental stewardship.

Further research could expand the discussion of comparative analysis between various urban waterfronts with distinct cultural and historical contexts. This may reveal how local narratives shape the sense of place and contribute to environmental sustainability. Additionally, investigating other types of urban spaces, such as parks and urban forests, can deepen the understanding of the role of the sense of place in diverse public spaces. Furthermore, incorporating the concept of sense of place into sustainable agendas can result in more effective approaches to promote environmental sustainability.

ACKNOWLEDGEMENT

The authors would like to thank all the participants in the survey and interview, and the support from Universiti Kebangsaan Malaysia (UKM).

DECLARATION OF COMPETING INTEREST

None.

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