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The Role of Sign Systems as A Factor in Behavioral Change of Users on Tunjungan Street as an Effort to Support Urban Sustainability: A Systematic Literature Review

Dwi Septi Permatasari[1], Susilo Kusdiwanggo[2], Agus Wiyono[3], Nur Luthfiatus Solikah[4]

Abstract

The complexity of urban environments requires effective navigation to be ordered in spatial behaviour, especially in commercial heritage areas such as Tunjungan Street, which go through a high traffic flow. Signage system serve as a cognitive elements that help the oriented and navigate a road users, but various form, design, and placement often effect in inconsistent navigation experiences. Yet there has been no comprehensive review examining the relation between signage characteristic, the visual perception, and behaviourof space users in the context of historic urban areas. This study uses a Systematic Literature Review of 10 selected articles to map the functions of signage, the visual cognition process, changes in public space behavior, and their implications for urban sustainability. The result shows that signage plays a role in enhancing the legibility of spatial information, reduce cognituive load and helped to guide movement patterns for both pedestriands and vehicles. This synthesis shows a knowledge gap regarding how signage functions as a spatial behavior controller in historic and high density areas to support the 11th point of SDGs. Therefore, prospect for future research is to focus on integrating signage design with mapping users cognitive load, also evaluating user behaviour to support safer, inclusive, and sustainable navigation.

Keywords: *Sign System; Signage; Visual Preseption; Spatial Behaviour; Cognitive Load.*

Introduction

Urban space is filled with layered interactions among pedestrians, cyclists, public transport, and private vehicle users, that couses a highly complex environment (Eshaghzadeh Torbati, 2018; Refnitasari et al., 2025). Issues such as user conflicts, unclear directional cues, reduced comfort, and safety risks often emerge due to this complexity (Berger & Craig, 2005; Wiyono et al., 2025). Within such conditions, signage systems play a crucial role in supporting orientation and navigation processes, enabling movement flows to occur more safely, efficiently, and in a more controlled manner for all space users (Arthur & Passini, 1992). As physical elements that carry visual messages, signage systems are not merely serve as location and direction information provider, but also movement behavior factor within dense urban environments (Lynch, 1960).

Generally, signage systems are known as visual component information instrument that depicts the identity, aesthetics and spatial image of a place (Astarini et al., 2022). The design component of signage such as its form, color, placement, hierarchy and graphic consistency influences how users read the environment and respond to it (V & Harilal, 2024). These visual elements play a role in managing the rhythm of movement, strengthening spatial legibility and creating a more intuitive spatial experience, more importantly in urban corridors designed for multiple user troupes, such as Jalan Tunjungan (Celik & Yildirim, 2025). High-quality signage motivates users to behave more discipline, become more spatially aware, and respond more effectively to traffic situations and the presence of other users (Gehl, 2011).

However, understanding the behavioral influence of signage systems is a multidimensional process. Spatial behavior is formed not only by users' informational needs but also by psychological, social, and cultural factors, along with distinguished visual perceptions between pedestrians and motor-vehicle users (J. Peng et al., 2025; Wang et al., 2024). Motorists need quickly readable and highly visible signs, whereas pedestrians need clear visual details at eye level. In high activity intensity urban spaces such as Tunjungan, these distinguished needs make a particular challenge in assessing

[1] Faculty of Engineering Brawijaya University, Indonesia Email: dwiseptip@student.ub.ac.id. (Correesponding Author)
[2] Faculty of Engineering, Brawijaya University, Indonesia.
[3] Faculty of Engineering, State University of Surabaya, Indonesia
[4] Faculty of Medecine, Surabaya State University, Indonesia

signage effectiveness (Khamimiya & Handoyo, 2023). Therefore, a systematic framework is needed to understand how signage construct movement patterns, decision-making, and the safety behavior of all users.

This article synthesizes theoretical developments, methodological approaches, and empirical findings related to the role of signage systems in forming user behavior as part of sustainable urban strategies. By reviewing ten Scopus-indexed articles from the fields of wayfinding, visual perception, environmental design, and spatial behavior, this study aims to identify the fundamental concepts of signage in urban contexts, the mechanisms through which it influences pedestrian and motorist behavior, also its implications for sustainable public-space design. Through this synthesis, the article is expected to offer new directions for designing signage that is not only functional and aesthetically coherent, but also capable of promoting safer, more orderly, more comfortable spatial behavior that aligns with the vision of sustainable cities.

Methods

This study employs a structured literature review method by searching the Scopus database using the keywords wayfinding, signage, behavioral characteristics, and pedestrian visual. The initial search yielded 100 articles, which were then screened based on relevance, alignment with the urban context, and their contribution to the discussion on the relationship between signage systems and user behavior in space. The evaluation considered research focus, methodology, and the extent to which it addressed navigation, visual perception, and behavioral responses among both pedestrians and vehicle users. This selection process resulted in 10 key articles deemed the most representative and closely aligned with the research topic. Therefore, all selected articles were analyzed using a thematic approach to identify patterns of findings, methodological differences, and conceptual frameworks regarding the role of signage systems in shaping spatial behavior and supporting urban sustainability.

Result

In this section, the findings from the 10 selected articles filtered through a rigorous selection process from an initial pool of 100 publications related to signage systems, wayfinding, visual preferences, and spatial user behavior are presented. Each article is treated as an independent unit of analysis, as they encompass diverse spatial contexts, methodological approaches, and research focuses, ranging from pedestrian environments and mixed traffic urban corridors to large-scale public spaces such as campus areas and city centers. A thematic analysis was establish to examine how each study discusses the function of signage systems, mechanisms of visual cognition and perception in the orientation process, behavioral patterns of pedestrians and vehicle users, and design implications for urban sustainability. Additionally, differences in spatial context, examined visual variables, and the characteristics of signage within each study were mapped to identify overarching trends as well as knowledge gaps that remain underexplored.

Table 1. The Result of The Research Used In This Literature Review Area.

No	Author and Year	Metode	Visual Perception	Signage or Wayfinding Characteristics	Synonyms	Main Findings
1	Yang et al., 2025	Agent-Based Modeling (ABM).	Emotional perception of space.	Spatial design elements influencing movement patterns and route choice.	Urban public space and pedestrian agents.	Public space design must consider pedestrians' affective responses to predict behavior; signage can be a directional variables for agents.
2	F. Peng et al., 2024	Complex Network Analysis.	Focus on structural understanding of signage systems.	Signage distribution, critical nodes, navigation flow continuity.	Guidance Signage System (GSS) and Guidance Service	Signage systems should be treated as networks; optimal placement is required at

					Network (GSN)	structurally significant nodes.
3	Zhou & Ujang, 2024	Survey, Visual Preference Test, CFA.	Visual preference, aesthetic perception, readability, and clarity.	Color, size, symbols, design consistency, material.	Wayfinding and signage	Aesthetic elements significantly influence user preference and navigation performance; signage must align with cultural context.
4	J. Peng et al., 2025	Field Test.	Visual search effectiveness.	Signage visibility, position, reading distance, and station layout	Wayfinding	Signage should minimize visual search load to improve navigation efficiency.
5	Jiang et al., 2025	VR-based eye-tracking and digital twin.	Visual attention (gaze time, fixation, and scanning).	Information density, size, angle, and orientation of signage.	Eye-tracking signage interaction.	Spatial positioning and orientation strongly affect visual attention; signage can be tested virtually before real implementation.
6	Celik & Yildirim, 2025	Space syntax, survey and cognitive mapping.	Legibility, spatial cognition, and orientation.	Landmark-based navigation, and environmental cues.	Wayfinding behaviour.	Spatial configuration and landmarks are more dominant than signage; signage must complement rather than contradict heritage context.
7	Calista et al., 2020	Signage & Wayfinding Design framework (Calori & Vanden-Eynden)	Visual preference and aesthetic perception.	Signage design standards, information hierarchy, color codes, material	Signage dan Wayfinding Design.	Consistent design and clear information hierarchy are essential for supporting visitor movement; relevant for institutional design standards.
8	Widjajanti et al., 2025	Case study and design analysis.	flow control cues.	Circulation direction in public spaces and user interaction zones.	Inclusive public space.	Although not focused on signage, the study highlights the need for spatial cues to balance informal and formal activities.
9	Wang et al., 2024	DeLone dan McLean Model.	User satisfaction, perceive d information	Information quality, system reliability, signage accessibility.	Signage system; information system quality	Information quality of signage affects satisfaction and usage intention; signage should be

			quality, and ease of use.			treated as an information system.
10	Kwon et al., 2025	Mobile eye-tracking.	Gaze behaviour, fixation, spatial cognition.	Route cues, maps, spatial orientation elements	Wayfinding design.	Gaze patterns reveal navigation confusion points; important to identify user confusion hotspots.

Function of Signage Systems and Wayfinding

The review of the ten selected articles indicates that signage systems function as key instruments supporting orientation, navigation, and the comprehension of urban spatial structure. The study by F. Peng et al., 2024 emphasizes that signage operates similarly to nodes within an information network, linking urban spaces and minimizing navigational confusion. A similar perspective is presented by Zhou & Ujang, 2024, who describe signage as a pedestrian facility that facilitates directional clarity, enhances mobility efficiency, and reinforces the spatial structure of an area.

Comparable findings appear in a VR eye-tracking study by Jiang et al., 2025, demonstrating how signage serves as a primary focal point of user attention and plays a decisive role in directional decision-making. In transit environments, (J. Peng et al., 2025) show that properly positioned signage minimizes directional search time significantly. Collectively, these studies confirm the primary role of signage is beyond simple directional guidance; it ensures orderly movement flows for both pedestrians and motor-vehicle users by establishing a structural component of public-space design.

Visual Cognition, Perception, and Psychological Factors in Wayfinding

Various studies emphasize that the effectiveness of signage systems is determined by how users perceive their visual elements (Zhou & Ujang, 2024b) explain that legibility, color contrast, and the aesthetic quality of signage directly influence visual preferences and user comfort levels. In the cognitive domain, Kwon et al., 2025 demonstrate that users' gaze patterns are highly dependent on the visual attractiveness of signage and the complexity of the surrounding environment.

VR-based research by Jiang et al., 2025 finds that users tend to prioritize signage with high visual saliency, particularly in situations involving high cognitive load. Additionally, Wang et al., 2024 reveal that perceived information quality and trust in signage design act as psychological factors shaping users' willingness to rely on signage systems. These findings confirm that visual cognition, aesthetic perception, and psychological factors are closely intertwined in determining the effectiveness of wayfinding.

Pedestrian Behavior and the Use of Public Space

The influence of signage systems on user behavior is strongly reflected across the literature. Yang et al., 2025 show that signage quality can alter navigation decisions, stopping behavior, and movement routes among pedestrians. Zhou & Ujang, 2024 amplify these results by pointing that pedestrians are more likely to choose spaces equipped with informative, consistent, and visually attractive signage.

In dense environments such as transit stations, J. Peng et al., 2025 demonstrate that improvements in signage reduce navigational errors and enhance movement efficiency. Beyond pedestrian movement, Widjajanti et al., 2025 highlight that signage also affects the distribution of activities in public spaces, including social interactions and economic activities. This indicates that signage have direct consequences for the dynamics of space at both individual behavior and public-flow patterns.

Implications for Public Space Design and Urban Sustainability

The literature consistently shows that signage hold a strategic role in supporting urban sustainability. Jiang et al., 2025 argue that signage integrated with the city's visual design can enhance safety, reduce mobility conflicts and encourage the use of environmentally friendly modes of travel. Zhou & Ujang, 2024 emphasize that effective signage improves walkability and strengthens the vitality of commercial districts.

In inclusive public spaces, Widjajanti et al., 2025 shows that signage can support diverse users, including hawkers, tourists, and vulnerable groups. Meanwhile, Calista et al., 2020 highlights the importance of maintaining visual consistency throughout urban design elements to build an information system that is easily understood by different user. Therefore, signage systems have immediate implications for spatial experience quality, sustainable urban mobility, and the city visual identity.

Discussion

The literature review demonstrates that signage systems serve functions beyond their role as simple navigational tools. All reviewed articles affirm that signage acts as a component of the city's informational infrastructure, regulating movement flows, reducing confusion and strengthening spatial structure (F. Peng et al., 2024; Zhou & Ujang, 2024). This structural function becomes particularly essential in a heritage corridor stuffed with tourism activities, vehicular traffic and pedestrian flows such as Tunjungan, due to its high spatial complexity and dense spatial interactions.

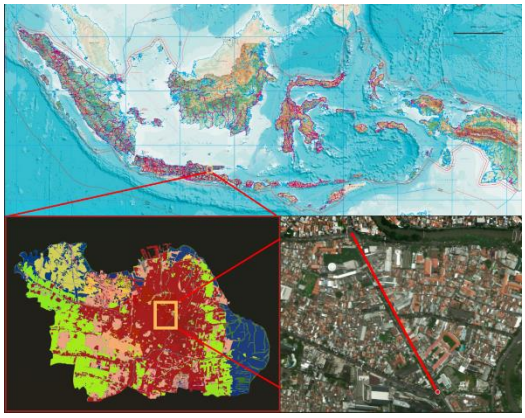

Figure 1. The Location of Tunjungan Street on Surabaya City

As information nodes, signage has the potential to minimize friction among various user groups, especially at intersections, commercial areas and transition points between vehicular and pedestrian areas. Hence, the effectiveness of the signage system in Tunjungan is determined more than just by its presence, but moreover by how it establishes and regulates movement patterns within a dense and historically layered urban landscape (Prabarini & Purwanto, 2023).

Figure 2. Wayfinding Sign on Tunjungan Street

Furthermore, visual cognition and perceptual processes play an important role in establishing wayfinding effectiveness. The literature highlights that users respond to signage based on its legibility, contrast, style consistency and visual significance (Kwon et al., 2025b; Zhou & Ujang, 2024a). VR and eye-tracking studies by Jiang et al., 2025 confirm how environmental complexity and the visual quality of the signage heavily affected users' visual attention. In Tunjungan, strong night lighting, messy commercial billboards and visually dominant heritage elements increase the potential for visual chaos.

Hence requires signage with stronger contrast, clearer structure and more robust visual characteristics (Kusliansjah & Patriajaya, 2022). Psychological factors, such as trust in the accuracy of information also influence users' dependance on signage systems. This underscores the need for signage design in Tunjungan to consider user cognition and accommodate unfamiliar users such as tourists (Wang et al., 2024).

From a behavioral perspective, the literature shows that signage has the ability to shape patterns of space use at both individual and district levels demonstrate that signage can influence decision-making, travel routes, and stopping behavior among pedestrians (Yang et al., 2025). In busy public spaces such as Tunjungan where pedestrians, street vendors, motor vehicles, and commercial activities intersect well organized signage can help reduce spatial conflicts and improve movement efficiency (Ashgaf et al., 2024; Kusliansjah & Patriajaya, 2022). Transit-related research indicates that accurate route labeling significantly reduces navigation errors, a finding relevant to Tunjungan during major events or peak tourism periods (F. Peng et al., 2024). Signage also affects the distribution of social and economic activities, suggesting that strategic placement of signage can help direct crowds toward specific areas or away from congestion-prone zones (Widjajanti et al., 2025).

The reviewed literature further states that signage systems have essential implications for public-space design and urban sustainability. Properly integrated signage enhances comfort, safety and accessibility (Jiang et al., 2025). In Tunjungan, integrating signage with the visual identity of the heritage corridor is important to preserve its character while supporting effective spatial orientation. Urban design studies (Calista et al., 2020) highlight that visual consistency across urban elements is prerequisite to develop an understandable information system to various user groups. This is particularly relevant as Tunjungan is visited by domestic and international tourists, older adults, the general public and vehicle users who need intuitive directional information. Hence signage functions as a practical feature and an integral part of urban branding strategies that support social, economic and mobility-related sustainability (Permatasari et al., 2025).

Overall, this discussion points out that the signage system throughout Jalan Tunjungan should be viewed as a strategic component in public-space management. Signage design must integrate findings related to navigational functions, visual-perception patterns, behavioral responses and the corridor's sustainability goals. Implementing an effective signage system in Tunjungan will improve movement efficiency and public-space vitality. Moreover it also minimize pedestrian conflicccts, vehicle conflicts and support the city's identity as a comfortable, safe and inclusive heritage district.

Conclusion

This literature review demonstrates that signage systems play an essential role in establishing user behavior within complex urban environments, including heritage corridors such as Tunjungan Street. The 10 analyzed articles consistently affirm that signage is not merely a navigational instrument but an element that influences visual perception, spatial orientation, sense of safety, and movement patterns of both pedestrians and vehicle users. Factors such as visibility, design consistency, color, contrast and context-appropriate placement are proven to determine wayfinding effectiveness, especially in environments with high visual clutter. In the context of Tunjungan, a corridor that rich in historical architecture, commercial activities and continuous vehicle flows, a clear and well-designed signage is essential to minimize confusion, guide movement flows, and preserve more organized, safe, comfortable and sustainable spatial behavior to support the 11th point of SDGs. These conclusions also highlight opportunities for future research involving empirical evaluation of user responses to actual signage in Tunjungan, to produce more accurate, inclusive, and evidence-based design recommendations

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