



# Post-Colonial Wayfinding to the Landmark: Turns, Angles, and Visibility Across Time

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**Abstract.** Colonialism in Indonesia leaves a profound mark on various aspects, including urban and spatial development. Many cities in Indonesia, such as Surabaya, evolve in accordance with the remnants of colonial city structure. The post-colonial urban development significantly affects how we navigate within the city, impacting our wayfinding performance, especially in transitional spaces. Of the many post-colonial marks, some landmarks remain, shaping the transitional space for wayfinding support. However, over the years, the city's morphology has evolved in accordance with the social dynamics of post-colonial society. With regard to the spatial transformation, this study aims to investigate the influence of postcolonialism in landmark wayfinding support. The study was conducted by analysing the city's morphology over three different timelines using the space syntax analysis method. The analysis covered several aspects, such as route decision, structural access, visual orientation, and landmark visibility. All the mentioned aspects are examined using various spatial datasets such as segment analysis, visibility graphs, and step depth. The result indicated that the colonial main structure persists among newly formed densities which are generated from the urban dynamic. Wayfinding support for accessing landmarks does shift due to the increase in density, which disrupts the landmark's visibility. These findings were indicated from the increasing average value of Visual Graph Analysis (VGA) despite varying results of segment analysis across time.

**Keywords:** Wayfinding, Space Syntax, Post-Colonial, Landmark, Transitional Space

## 1 Introduction

Post-colonial city development in Indonesia is marked by spatial layers shaped by the colonial urban development legacy and modern urban intensification [1]. Dutch East Indies colonization, introduced a hierarchical street structure, racial zone segregation, and zoning that organized movement and social order to Indonesian urban planning and morphology [2], [3], [4]. Currently, the spatial structure persist and continue to surface

in post-colonial cities, including Surabaya, which has been the center of important port and East Java trade [5], [6].

The surrounding area of the *Jembatan Merah* (Red Bridge) in Surabaya, formerly known as the European Quarter, is a real example of the colonial city morphology legacy [4]. This area was developed across the Kalimas River waterfront adjacent to Chinese and Arab quarters, forming a city structure which reflects the social and economic segregation during the colonial era [3]. Nevertheless, the current Surabaya city morphology no longer reflects the colonial city pattern. But instead it indicated a deviation and transformation due to the densification process, commercial area development, and adjustment to modern civilization demands [1]. Several studies mentioned that despite remaining primary spatial structure, many colonial buildings develop transformations in shapes and function. For instance, *Jembatan Merah Plaza* (JMP) shopping mall replaced a historical colonial warehouse in the 1990s [4]. Moreover, the newest research also indicated the emergence of counter-mapping and colonial legacy reinterpretation within the contemporary Surabaya city design [7].

These conditions indicate that post-colonial cities have a layered morphology: colonial patterns are still legible in the macrostructure, with more complex and dynamic structure at the micro level. The apparent changes would have a direct impact on the wayfinding process, which is an individual's ability to navigate within a space through directional support, route decisions, and landmark visibility [8]. Moreover, in the spatial cognition context, spatial orientations are significantly dependent on the interplay of spatial structure, visual field, and landmark visibility, which together form the cognitive foundation for spatial understanding [9].

Quantitative approaches such as segment analysis and visibility graph analysis (VGA) from space syntax theory provide quantitative methods to understand the relationship between city structure and navigation behaviour [10]. Integration and choice metrics can be used to measure the to-movement and through-movement, while visibility analysis helps to measure the field of view and visual pull [11], [12]. In a post-colonial context, densification and building shape transformation could increase the spatial accessibility but also reduce the spatial legibility at the same time. The situation could cause the shift of orientation from natural spatial cues to artificial signage or spatial memory.

With the mentioned background, the study aims to investigate how the spatial structure could influence the wayfinding process in reaching a landmark in Surabaya within three different periods (1897, 1934, 2025). This study focuses on landmark wayfinding due to its role in inducing natural behaviour in urban navigation [13]. The analysis was conducted by evaluating four main dimensions: (1) route decision, (2) structural access, (3) visual orientation, and (4) landmark visibility. Through comparative spatial and visual analyses, this research seeks to reveal how post-colonial morphological transformation reshapes the spatial supports for navigation and environmental legibility and how colonial spatial frameworks continue to influence or gradually fade within the modern urban fabric of Surabaya.

## 2 Methodology

This study aimed to investigate how spatial structure affects wayfinding to a landmark within a post-colonial context across three periods (1897, 1934, 2025). To identify supports for wayfinding, the study focused on movement-driving forces expressed through visual and spatial entities. The wayfinding dimensions being assessed were route decisions, structural access, visual orientation, and landmark visibility, which were measured with space syntax analysis [14] (Table 1). Route decisions reflect turn complexity and decision load by observing the number and sharpness of turns within the overall spatial structure shown in angular step depth measurement. This metric captures the cognitive load from turn sequences along the route. Structural access indicates spatial reachability and through-movement potential with respect to overall urban mobility. It captures how the street network structurally supports getting to and moving through the route. Visual orientation represents the visual pull and the field of view from selected wayfinding points by indicating whether space guides the gaze and how wide the scene is at decision points. Landmark visibility is assessed through visual step depth to capture the visibility of the target landmark, which analyses the number of visibility “hops” before the landmark is seen/confirmed. Various spatial contexts supporting wayfinding include spatial structure, which encourages movement and choice. Visually, urban topology examines how spatial elements and landmarks contribute to movement and visibility.

**Table 1.** Wayfinding dimensions and metrics used to assess route decisions, structural access, visual orientation, and landmark visibility.

Wayfinding Dimension (Category)	Description	Metrics
<b>A. Route decision</b> Turn Complexity & Decision Load	Cognitive load from turn sequences along the route	Step-depth (angular)
<b>B. Structural access</b> Reachability & Through-ness	How the street network structurally supports getting to and moving through the route	$NAIN_r$ (to-movement) along the route (mean & min); $NACH_r$ (through-movement) peaks at nodes.
<b>C. Visual orientation</b> Visual Pull & Field of View	Whether space <i>guides the gaze</i> and how wide the scene is at decision points	VGA FPM (drift magnitude & direction)
<b>D. Landmark visibility</b> Seeing the Target, Step-by-Step	How many visibility “hops” before the landmark is seen/confirmed?	Step-depth (visual)

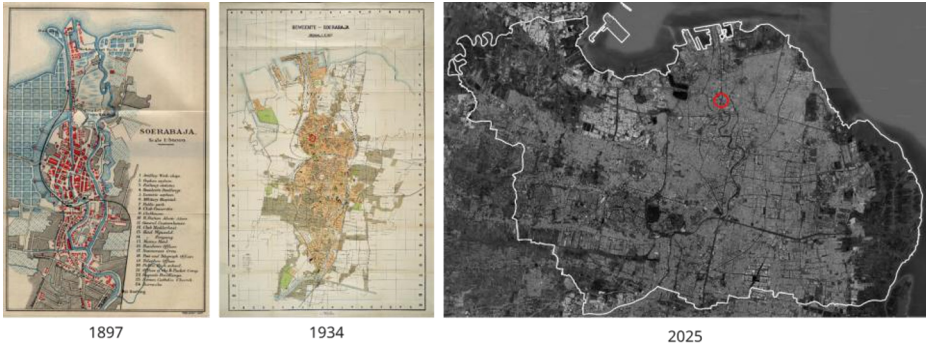
### 2.1 Case Study

The selected case study in this research is located in the old city area of Surabaya, specifically in an area known as the European Quarter nearby the historical *Jembatan Merah* (Red Bridge). This area was chosen because it was a core part of Surabaya's early development during the colonial period, which features numerous heritage colonial buildings that are densely packed and serve significant commercial functions. This area also represents a typical colonial city structure, which possesses an ordered grid of streets, constricted corridors, and building fronts set to the principal axis of the main commercial area, lining up across the Kali Mas riverfront. With such character, this area becomes an ideal site to evaluate the spatial support of wayfinding activities, especially in the context of colonial and post-colonial history.

The research area was limited to a 400-meter radius from the centre of *Jembatan Merah*. This radius is selected to reflect the shortest walking distance coverage, which is still relevant for pedestrian orientation in the context of the historical city. Furthermore, this radius also allows for the evaluation of segment analysis within a fairly dense yet controlled scope, allowing detailed analysis of connectivity and spatial integration patterns without losing the immediate environmental context surrounding the landmark. The selection of this radius also takes into account the density of colonial buildings that are still maintained in the area to this day so that the results of the analysis can describe the continuity and changes in the spatial structure and orientation of public spaces temporally.

The analysis was conducted within three time periods: 1897, 1934, and 2025. These three time periods were selected to represent the change of spatial structure across time, from early colonial to late colonial to the modern post-colonial (Figure 1). This study uses three cartographic sources: (1) the historical map *Soerabaja* (Scale 1:50,000), 1897, from J. F. van Bemmelen and G. B. Hooyer's *Guide to the Dutch East Indies*, with image courtesy of the Perry-Castañeda Library Map Collection, University of Texas at Austin; (2) *Gemeente–Soerabaja* (Scale 1:10,000), c. 1934, published by N.V. v/h H. van Ingen (*Soerabaja*), retrieved from Leiden University Libraries – Digital Collections; and (3) a contemporary 2025 basemap derived from OpenStreetMap data (© OpenStreetMap contributors, used under the ODbL 1.0). By comparing these three periods, this study seeks to identify how the city's spatial and visual structure could influence the wayfinding support over time.

Street-network and building-block layers for 1897 and 1934 were created by manually digitising features from the original maps after georeferencing them to Surabaya's present-day urban framework using stable control points (bridge and road intersections) and river alignments (Figure 2). Surabaya 2025 street-network and building-block layers were collected from Open Street Map (OSM). To provide an accurate comparative spatial analysis, the spatial blocks need to be in a similar state. However, building block layers from 1897 and 1934 were drawn in a simpler state, illustrating the urban blocks. Therefore, the Surabaya 2025 building block layers were simplified to create an urban block similar to the older map period (Figure 3). The building block simplification is significant in creating a more accurate spatial analysis, especially for Visual Graph Analysis (VGA), which is generated from the spatial visibility.



**Fig 1.** Historic (1897, 1934) and present-day (2025) views of Surabaya aligned to a common extent; the red circle marks the study landmark used in the wayfinding analysis.



**Fig 2.** Digitised maps used for the analysis, derived from three original map sources. The red circle indicates the study radius, and the grey shaded polygon shows the digitized building or urban block layer.



**Fig 3.** Surabaya 2025 building block simplification Left is the original building blocks; right is the simplified result.

The landmark chosen as the centre of identification is De Javasche Bank, which is now known as the Bank Indonesia Museum. De Javasche Bank was selected due to its consistent acknowledgement as a landmark in all three map periods (Figure 4). Despite the transformation of the building's function from colonial bank to national museum, the building positions within the city structure remained well-maintained. Its consistent existence and visibility as a landmark make it an ideal reference point for evaluating how the spatial support for landmark reachability changes throughout Surabaya City's

morphological evolution, transitioning from the hierarchy of colonial structures to a more complex post-colonial urban setting.



11. *General Customhouse.*

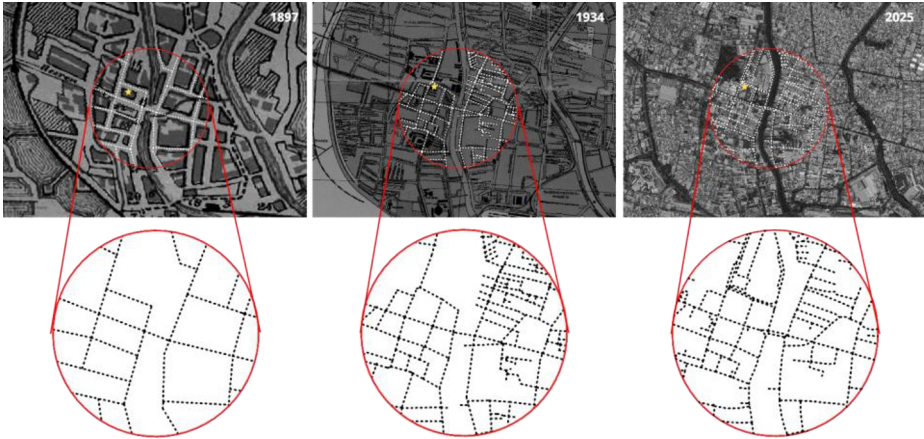
**Fig 4.** Close-up views of the study landmark and its immediate surroundings in 1897, 1934, and 2025. Red shades indicate the position of De Javasche Bank.

### 3 Results and Discussion

#### 3.1 Overall Spatial Performance

Figure 5 showed Surabaya city's morphological change across three different periods, 1897, 1934, and 2025, which illustrate the spatial structure transformation around the centre of Surabaya's European Quarter. Generally, the street structure and block density seem to experience significant change across timelines. In the year 1897, the city structure tended to be open and spacious, with a linear network pattern following the Kali Mas waterfront. The main circulation directions are still quite distinct, connecting the colonial commercial corridor and the central government area. Coming into the year 1934, the city network started to fill in with more blocks and new street branches surrounding the commercial area. The density rose, but the main street networks are still well defined due to the sustained colonial urban pattern around the Jembatan Merah area. As of 2025, the city's structures have become much denser and more fragmented, with numerous additions to local streets, alleys, and modern buildings that obscure many of the old corridors. The development pattern is no longer following the river axis but spreading in various directions, indicating a transition from a structured colonial city pattern to a more layered and organic one.

Overall, this transformation indicated a shift from a hierarchical structure to a distributed network, where the dominant direction weakens as density and complexity increase. Those transformations become the main background to understand how the spatial support of wayfinding also changes across timelines.



**Fig 5.** Landmark-area spatial structure across 1897, 1934, and 2025; lower panels show the road pattern traced from the maps.

### 3.2 Route Decision

The analysis of the route decision aimed to examine how the complexities of route and load decisions were influenced by the city structure surrounding the landmark. This dimension is focusing on how far the spatial user needs to make directional decisions or turn during movement towards the landmark, which reflects the legibility and way-finding efficiency within the city structure. The evaluation was done through angular step depth analysis, which is used to measure how "direct" or "winding" a route is according to the angular deviation between connected street segments. The minimum, maximum, and average values are shown in table 2.

Angular step depth analysis works by measuring the level of route complexity according to the cumulative change between consecutive street segments. Each intersection or turn was considered as a step, which is a decision point that needs to be taken by the spatial user while moving toward their destination. High value indicated that the route has more turns and requires a greater cognitive load in the navigation process.

In the analysis map (Figure 6), the red-yellow colour demonstrates a lower angular depth, which means that the route is more direct and easy to remember. Meanwhile, the green-blue colour illustrates a higher angular step depth value, which indicates a more complex and winding route. The minimum value indicates the origin segment, the mean value depicts overall network complexity, and the maximum value identifies the most angularly convoluted routes.

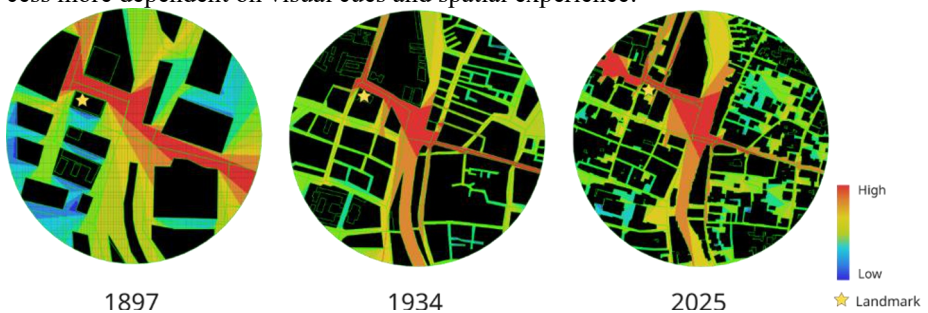
In 1897, the street network at its centre was still linear and directional, following the main axis of Kali Mas. The dominant red-yellow colour showed that the route heading to the landmark was quite direct and easy to remember, with a small number of intersections and a consistent directional pattern. This condition supports intuitive navigation, because the users would be able to maintain a stable visual reference toward the

landmark. The Angular Step Depth values ranged from 0 to 2.11, with an average of 0.81, confirming that routes were short and cognitively simple.

By 1934, the Angular Step Depth value had increased, indicating additional intersection and branching corridors. Even though the main directions are still identifiable, the intersection distributions are more symmetrical against the landmark position; therefore, the movement tendencies are beginning to require more directional decision-making. The colonial structure still provided a guiding framework, but the clarity of directional orientation began to diminish. The average value rose to 1.11 (with a maximum of 3.80), reflecting a measurable increase in route complexity and the number of directional shifts.

Meanwhile, 2025 angular step depth analysis showed higher density and fragmentation of the city network, with high-valued zones (red) spreading more in various directions, including both of the riverside areas. This situation signifies the disappearance of the primary spatial structure that served as a natural route to the landmark. The users are currently faced with more alternative paths and turning points, which are causing an increase in the wayfinding cognitive load, even though overall connectivity and accessibility have improved. The average Angular Step Depth further increased to 1.16, indicating that the modern urban network demands more turns and a greater cognitive effort to maintain orientation toward the landmark.

Overall, the Angular Step Depth across the timeline showed transitions from a hierarchical and legible colonial network toward a more complex and distributed post-colonial configuration. These transformations indicate that, despite the increase in accessibility, landmark directional clarity can decrease, making the spatial orientation process more dependent on visual cues and spatial experience.



**Fig 6.** Surabaya Angular Step Depth Analysis in the years 1897, 1934, and 2025

**Table 2.** Summary Statistics of Angular Step Depth (1897, 1934, 2025)

Year	Minimum	Average	Maximum
1897	0	0.80952	2.11015
1934	0	1.10656	3.79916
2025	0	1.16219	3.80513

### 3.3 Structural Access

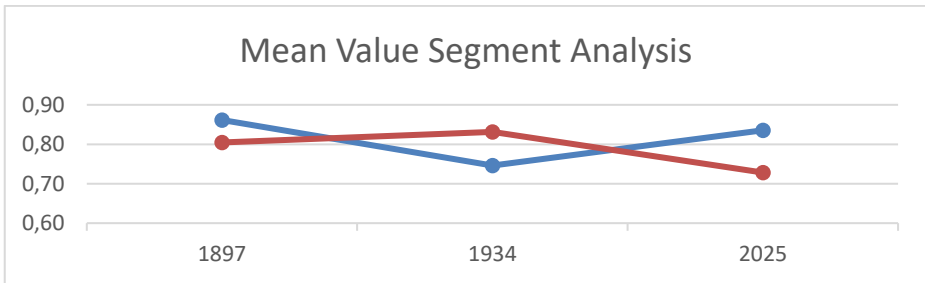
The structural access analysis aims to evaluate the spatial value of reachability and through-movement in supporting wayfinding towards the landmark. This dimension focuses on the extent of spatial structures in enabling local and global efficient movement, which is a fundamental insight into user accessibility and spatial orientation. The analysis was conducted by utilising segment analysis with two main indicators: Normalised Angular Integration (NAIN), measuring to-movement, or the ease of reaching a point of a spatial network, and Normalised Angular Choice (NACH), measuring through-movement, or the frequency of a street segment functioning as a potential route between multiple points.

Principally, NAIN represents the degree of accessibility. The higher the value, the easier it is for a certain point to be accessible from other networks. On the contrary, NACH illustrates the movement flow potential. A higher value indicates a greater opportunity for the segment to facilitate movements towards other destinations, and it can also be interpreted as a measure of spatial centrality. High-value street segments are shown in a red-yellow colour, indicating high access or flow intensity. Low values are represented in green-blue, indicating low access or limited flow. Figure 7 illustrates the spatial distribution of NACH and NAIN values, which visually indicate the level of accessibility and movement patterns that change from the concentrated colonial axis to a more distributed post-colonial urban network.



**Fig 7.** Surabaya Normalised Integration (NAIN) and Normalised Choice (NACH) in the years 1897, 1934, and 2025

Figure 8 and Table 3 illustrate the variation of Normalised Angular Integration (NAIN) and Normalised Angular Choice (NACH) in the years 1897, 1934, and 2025. Both metrics indicate a contrasting pattern where the NACH value declined from 0.86 in 1897 to 0.75 in 1934 before rising again to 0.83 in 2025. Meanwhile, NAIN showed a slight increase from 0.80 in 1897 to 0.83 in 1934, which was followed by a sharp drop to 0.73 in the final period. This pattern demonstrates a clear transition in accessibility structure, from a centralised and hierarchical colonial system to a more distributed post-colonial network. Meaning that movement potential is increasing, yet directional efficiency toward the landmark is gradually weakened over the period. The standard deviation values (ranging between 0.41 and 0.56) suggest that this transformation resulted from a gradual redistribution of connectivity rather than abrupt spatial disparities.



**Fig 8.** Mean segment-analysis values for through-movement (NACH) and to-movement/reachability (NAIN) across 1897, 1934, and 2025.

**Table 3.** Summary statistics (mean and standard deviation) of NACH and NAIN by year (1897, 1934, 2025).

Metric	1897		1934		2025	
	NACH	NAIN	NACH	NAIN	NACH	NAIN
Mean	0.86	0.80	0.75	0.83	0.84	0.73
Std Dev	0.57	0.151	0.58	0.42	0.41	0.49

Overall, the results from NAIN and NACH demonstrate the transition from a hierarchical colonial structure to a post-colonial structure, which is denser and more distributed. Despite a rise in connectivity, the clarity of directional access to the landmark weakened, which implicates the drop of spatial legibility and the rise of dependency on visual cues and spatial experience for wayfinding.

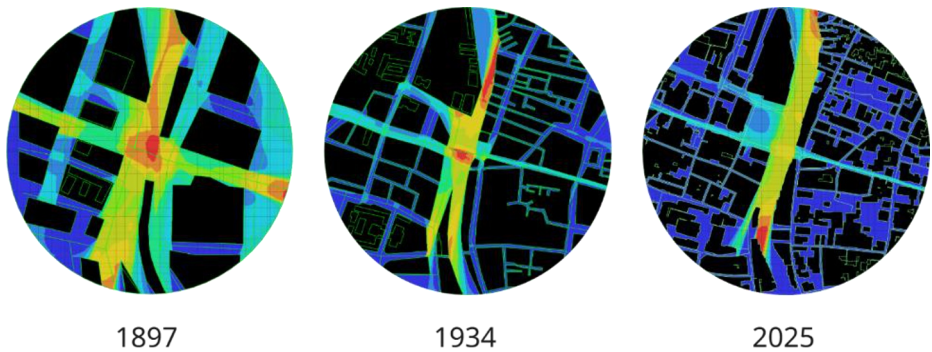
### 3.4 Visual Orientation

Visual orientation analysis aimed to evaluate how visual pull and field of view influence the user orientation experience within the city space. This dimension measures the extent of spatial configuration in supporting the user's ability to capture the movement direction and to identify the visual orientation. The evaluation was commenced using Visibility Graph Analysis (VGA) with two main parameters: First Point Movement

(FPM), which depicts the direction and magnitude of visual drift, and connectivity, which demonstrates the degree of visual openness or intervisibility among spaces [10].

Generally, high FPM values indicate strong visual guidance and wider visibility fields, whereas lower values indicate restricted or obstructed views, which are caused by dense physical structures [15]. In VGA, the red-yellow colour represents areas with high connectivity and visual pull, while the green-blue colour indicates areas with visual restrictions. The average value was used to demonstrate the visual openness tendency in the overall network structure.

Figure 9 showed a VGA result in the years of 1897, 1934, and 2025, which illustrates FPM spatial distribution and visual orientation transformation around the landmark area over time. Visually, areas with high value (red colour) were reduced from time to time, indicating a gradual loss of long-range visibility and weakening of dominant visual corridors. Meanwhile, Table 4 showed the minimum, average, and maximum value of VGA FPM for each period. The FPM average value drastically drops from 2,544,530 in 1897 to 455,859 in 1934 and remains low at 604,195 in 2025, while the maximum decreases from 6,527,460 to 3,444,870. This trend showed that building density and modern spatial fragmentation progressively reduce visual openness and obscure the visual cues that once guided users intuitively toward the landmark.



**Fig 9.** Surabaya VGA-FPM analysis in the years 1897, 1934, and 2025

**Table 4.** Summary statistics (minimum, mean, maximum) of VGA Point First Moment (FPM) within the landmark area by year (1897, 1934, 2025).

Year	Minimum	Average	Maximum
1897	59605.9	2545430.0	6527460.0
1934	100.74	455859.0	2079880.0
2025	22.9574	604195.0	3444870.0

Overall, the declining FPM value illustrates the shift from a colonial environment, which was open and visually easy to read, to a dense and fragmented post-colonial

space. This condition demonstrates that city densification is not only affecting the physical structure but also reducing the visual clarity and the natural guidance that previously supported intuitive wayfinding.

### 3.5 Landmark Visibility

The landmark visibility examines the evolution of landmark visibility within the context of city morphology, spanning from the colonial to the post-colonial period. This dimension evaluates how fast and how often a landmark can be seen along the route, which directly affects the process of orientation and decision-making in wayfinding. The valuation was done using Visual Step Depth Analysis, which measures the number of visual “hops” required to see the landmark from any given point within the street network [15].

A low visual step depth value indicates that the landmark was visible earlier and more directly, whereas a high value indicates that the landmark's visibility was obstructed or could only be seen after several visual step depths. The analysis map (Figure 10) showed a visibility value with colour gradation from red (high/easily seen) to blue (low/harder to see). The average value was used to illustrate the general visibility degree, while the maximum value demonstrates the maximum visibility value furthest from the landmark.

Table 5 showed statistical landmark visibility for each period. The results indicated a gradual rise in visibility scores, increasing from 2.53 in 1897 to 2.89 in 1934 and reaching 3.03 in 2025, along with an increase in the maximum value from 4 to 7. The increasing value indicated that the landmark is getting harder to see directly, along with the rise of density and city complexity. Visually, the city map in 1897 showed that the landmarks are visible from various directions, with wide red areas along the main corridor. By 1934, the visible area was shrinking because new buildings were emerging in the colonial commercial district. In 2025, although some main corridors remain open, the visible areas shrink even further, which reflects greater visual obstruction and a decline in direct visual orientation toward the landmark.

Overall, this result showed the landmark visibility has decreased from time to time. In a wayfinding context, this condition means that a landmark that previously functioned as a natural visual anchor is now playing a role as a symbolic element, as its visual prominence is increasingly constrained by the complexity and enclosure of the modern urban environment.



**Fig 10.** Surabaya Visual Step Depth analysis in the years 1897, 1934, and 2025.**Table 5.** Summary statistics (minimum, mean, maximum) of Visual Step Depth by year (1897, 1934, 2025).

<b>Year</b>	<b>Minimum</b>	<b>Average</b>	<b>Maximum</b>
1897	0	2.53103	4.0
1934	0	2.8892	7.0
2025	0	3.02669	7.0

## 4 Conclusion

The finding of this study demonstrated that Surabaya's spatial structure has significantly shifted from a legible, hierarchical colonial order to a denser and more fragmented post-colonial configuration. The four-wayfinding dimension analysis (route decision, structural access, visual orientation, and landmark visibility) reveals increasing route complexity, more distributed accessibility, declining visual openness, and reduced landmark visibility. These transformations highlight city network transitions from a directed and legible urban form to a complex multi-directional structure. Subsequently, the city morphology transformation is not only influencing the physical environment but also the user cognitive experience, especially in navigating and understanding the city layout.

Additionally, this study underscores that post-colonial wayfinding no longer depends on one dominant direction or single landmark but also on spatial interpretation, which is more contextual and adaptive. With the increase in network complexity, users must rely more on artificial visual cues, experiential memory, and localised navigation strategies. In the Surabaya context, this situation reflects the shift which originally placed the landmark as a centre of visual and symbolic importance during the colonial period to a more plural post-colonial orientation, where the landmark still stands as an important piece in a more complex spatial network.

These insights have broader implications for urban design and spatial planning. Additionally, understanding the relationship between spatial structure and wayfinding behaviour can provide a fundamental foundation for creating a more legible city network that supports intuitive navigation. For historic cities like Surabaya, the revitalisation strategy needs to consider the balance between modern densification and colonial visual orientation preservation so that spatial identity and orientation capabilities are sustained amidst morphological transformation.

While this study provides a comprehensive understanding of spatial structure transformation in wayfinding support, there are still several limitations that need to be acknowledged. The analysis focused on spatial representation through visual and segment-based modelling without incorporating direct user behaviour data. Therefore, future research could integrate empirical data from user simulation and survey to cognitively validate the spatial findings. Moreover, a comparative study across cities or urban typologies could help explain wayfinding patterns in different post-colonial contexts.

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## Data availability

The datasets for this research can be accessed at <https://doi.org/10.4121/35a48698-5565-48e6-9b49-88eee1a21f46.v1>.

## References

- [1] A. Pamungkas, D. Iranata, J. Yuwono, and L. M. Jaelani, ‘An insight on Surabaya development: pre colonials, colonial, post colonial and current era’, *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 340, no. 1, p. 012002, Oct. 2019, doi: 10.1088/1755-1315/340/1/012002.
- [2] P. Basundoro, *Pengantar sejarah kota*. Ombak, 2012.
- [3] F. Colombijn and M. Barwegen, ‘Racial Segregation in the (Post) Colonial City: The Case of Indonesia 1’, *Urban Geography*, vol. 30, no. 8, pp. 838–856, Nov. 2009, doi: 10.2747/0272-3638.30.8.838.
- [4] T. Kwanda, ‘The Morphological Framework of the Chinese and the European Districts in Surabaya, 1787–2005’, *DIMENSI (Journal of Architecture and Built Environment)*, vol. 38, no. 1, pp. 1–14, 2011, doi: 10.9744/dimensi.38.1.1-14.
- [5] H. Rinardi and Y. Rochwulaningsih, ‘Inter-islands Dynamic Economy: Colonial Policy on the Indonesian Ports Development for International and Domestic Shipping During Colonial Times’, *Journal of Maritime Studies and National Integration*, vol. 4, no. 1, pp. 33–44, Jun. 2020, doi: 10.14710/jmsni.v4i1.7899.
- [6] P. Tutuko, N. Bonifacius, D. Yuniawan, and R. M. B. Jati, ‘Measuring Spatial Arrangement of Indonesian Colonial Cities using Depth and Connectivity Calculations: Ratio study on master plans using Space Syntax’, *International Review for Spatial Planning and Sustainable Development*, vol. 9, no. 4, pp. 67–81, 2021, doi: 10.14246/irspsd.9.4\_67.
- [7] A. Crosby, A. Silvia, C. Tifani, and M. E. Imantaka, ‘Counter-mapping Surabaya: Designing “cities within the city”’, *Cities*, vol. 145, p. 104675, Feb. 2024, doi: 10.1016/j.cities.2023.104675.
- [8] A. Schwering, Krukar ,Jakub, Li ,Rui, Anacta ,Vanessa Joy, and S. and Fuest, ‘Wayfinding Through Orientation’, *Spatial Cognition & Computation*, vol. 17, no. 4, pp. 273–303, Oct. 2017, doi: 10.1080/13875868.2017.1322597.
- [9] A. W. Siegel and S. H. White, ‘The Development of Spatial Representations of Large-Scale Environments’, in *Advances in Child Development and Behavior*, vol. 10, H. W. Reese, Ed., JAI, 1975, pp. 9–55. doi: 10.1016/S0065-2407(08)60007-5.
- [10] A. Turner, M. Doxa, D. O’Sullivan, and A. Penn, ‘From isovists to visibility graphs: A methodology for the analysis of architectural space’, *Environment and Planning B: Planning and Design*, vol. 28, no. 1, pp. 103–121, 2001, doi: 10.1068/b2684.

- [11] B. Hillier, A. Penn, J. Hanson, T. Grajewski, and J. Xu, 'Natural Movement: Or, Configuration and Attraction in Urban Pedestrian Movement', *Environ Plann B Plann Des*, vol. 20, no. 1, pp. 29–66, Feb. 1993, doi: 10.1068/b200029.
- [12] C. Yamu, A. van Nes, and C. Garau, 'Bill Hillier's Legacy: Space Syntax—A Synopsis of Basic Concepts, Measures, and Empirical Application', *Sustainability*, vol. 13, no. 6, Art. no. 6, Jan. 2021, doi: 10.3390/su13063394.
- [13] A. Makri, S. Zlatanova, and E. Verbree, 'An Approach for Indoor Wayfinding Replicating Main Principles of an Outdoor Navigation System for Cyclists', *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol. XL-4-W5, pp. 29–35, May 2015, doi: 10.5194/isprsarchives-XL-4-W5-29-2015.
- [14] B. Hillier, *Space is the machine: a configurational theory of architecture*. London, UK: Space Syntax, 2007. Accessed: Aug. 03, 2025. [Online]. Available: <https://discovery.ucl.ac.uk/id/eprint/3881/>
- [15] A. Van Nes and C. Yamu, *Introduction to Space Syntax in Urban Studies*. Cham: Springer International Publishing, 2021. doi: 10.1007/978-3-030-59140-3.

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