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Seeing and being seen: spatial visibility and the pedestrian mobility in urban public squares

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Despite extensive research on urban public spaces, many studies primarily focus on physical design attributes such as seating, greenery, and aesthetic improvements, while comparatively less attention has been given to the relationship between spatial configuration, visual permeability, and observed pedestrian presence in neighborhood squares. Consequently, some public spaces remain underused despite offering comparable urban amenities and physical qualities. In response to this gap, this study investigates the relationship between spatial visibility, configurational attributes, and pedestrian mobility in urban public squares. The research aims to examine how differences in spatial configuration and visibility conditions correspond with variations in pedestrian movement patterns within public spaces. A quantitative comparative approach was adopted, combining empirical pedestrian observations with configurational spatial analysis based on space syntax theory, Visibility Graph Analysis (VGA), land use mapping and Isovist analysis. Two neighborhood squares in Cagliari, Italy, were selected as comparative case studies. The results indicate that squares characterized by stronger visual accessibility and clearer visual permeability to surrounding streets are associated with significantly higher levels of pedestrian presence. In contrast, visually concealed spaces with fragmented visibility structures correspond with lower levels of observed pedestrian activity despite offering similar amenities. Furthermore, the findings demonstrate that higher local spatial integration alone does not necessarily correspond to greater pedestrian presence. Instead, visual permeability and visibility from the surrounding street network emerge as decisive factors influencing the intensity and distribution of pedestrian activity within neighborhood public squares. The originality of this research lies in demonstrating that local spatial integration alone is insufficient to explain pedestrian use of neighborhood public squares, highlighting the complementary role of visual permeability and surrounding visibility conditions through the combined application of axial analysis, VGA, Isovist analysis, land use mapping, and empirical observation. The findings contribute to ongoing discussions on visibility-sensitive urban design and evidence-informed planning approaches for improving the vitality of neighborhood public spaces.

KEYWORDS
behavioural patterns, pedestrian mobility, social interaction, space syntax, spatial configuration, urban public space, visual permeability

1 Introduction

Cities are experienced not only through their physical structures but also through what can be seen, perceived, and understood while moving through urban space (Gehl, 2011). In public urban spaces, spatial visibility plays a fundamental role in shaping how people navigate, interpret, and interact with their surroundings (Natapov and Fisher-Gewirtzman, 2016). The ability to see across a space and visually connect with surrounding paths, entrances, and activities influences how individuals orient themselves and decide where to move (Pylyshyn, 2007). When public spaces provide clear sightlines and visual continuity, they tend to support intuitive movement, enhance spatial legibility, and encourage pedestrian presence and informal social encounters (Hespanhol and Tomitsch, 2015). Conversely, fragmented visibility, visual barriers, or poorly connected edges can limit spatial awareness and reduce the attractiveness of a space for movement and lingering (Peng et al., 2025). In this sense, visibility is not merely a visual attribute of urban design but a spatial condition that directly affects pedestrian mobility and the social functioning of public spaces (Foltête and Piombini, 2007).

Despite the extensive body of research on public squares and urban vitality, many studies still focus primarily on physical design elements, such as the provision of greenery (Kumar and Vuilliomenet, 2021), seating (Akinci et al., 2022), small-scale interventions (Alshafei, 2025), or landscape improvements (Zhang et al., 2021), when evaluating the success of public spaces. Specifically, many studies have examined the role of spatial configuration and visibility using space syntax techniques, including VGA, to investigate pedestrian movement (Hegazi et al., 2022; Omrani Azizabad et al., 2025; Bendjedidi et al., 2018) and socio-spatial behaviour (Chen et al., 2025; Safari and Moridani, 2017; Shen and Wu, 2022). However, existing studies have primarily focused on validating configurational measures (Dastoum et al., 2026), evaluating individual public spaces (Zerouati and Bellal, 2020), translating socio-spatial logics (Moosavi et al., 2026), or analysing broader urban systems (Alam et al., 2026). Comparatively less attention has been devoted to explaining why neighbourhood squares with similar physical amenities and functions display markedly different levels of pedestrian activity through an integrated comparison of spatial configuration, external visual permeability, surrounding land-use context, and observed behavioural patterns. While physical design elements such as greenery, seating, and landscape improvements remain important, there is still limited evidence on how these spatial factors interact to influence the everyday performance of comparable neighbourhood public spaces. Addressing this gap requires analytical approaches that integrate configurational analysis with empirical observations and contextual urban characteristics.

This study therefore focuses on the relationship between visibility, spatial configuration, and public life in urban squares, aiming to better understand why some public spaces become active social environments while others remain relatively quiet despite similar physical features. To investigate this relationship, the study adopts the analytical framework of space syntax, a methodology that examines how the configuration of urban space influences movement patterns, visibility, and opportunities for social interaction (Hillier and Hanson, 1984). By analysing spatial configuration, visual connectivity, and pedestrian movement potential, space syntax provides a systematic approach for linking the physical structure of the built environment with patterns of urban activity (Hillier et al., 1976). In particular, techniques such as VGA allow researchers to identify how spatial accessibility and visual fields shape the ways people perceive, navigate, and use public spaces (Hillier, 2007). In this context, Piazza Galileo Galilei and Piazza Michelangelo in the San Benedetto district of Cagliari are selected as case studies, as both squares provide comparable public facilities and neighborhood functions yet exhibit different levels of pedestrian activity and spatial integration. Examining these two squares offers an opportunity to investigate how spatial configuration and visibility conditions may explain why some public spaces thrive while others remain relatively quiet despite similar physical features.

To address this research aim, the study investigates how spatial structure and visual connectivity influence the performance of urban public spaces. In particular, it seeks to understand how differences in spatial configuration may shape pedestrian movement and the overall mobility of neighborhood squares. Accordingly, the research addresses two main questions: (1) How do spatial configuration and visual permeability are correspond with the pedestrian movement patterns in urban squares? (2) How can space syntax analysis help explain why some urban squares attract higher pedestrian movement while others remain relatively underused despite offering similar physical facilities? By addressing these questions, the study aims to reveal how the spatial logic of public spaces contributes to their social performance and everyday use. The structure of this paper is as follows. The subsequent section presents the research methodology, including empirical observation, VGA and isovist analysis used to evaluate spatial visibility and pedestrian movement. The following section presents and discusses the results of the spatial analyses and observational data for the two case study squares. The paper concludes with a summary of the main findings and their implications for urban design and public space planning, as well as suggestions for future research.

2 Theoretical framework

2.1 Space syntax theory

Space syntax theory provides a theoretical foundation for understanding how the spatial configuration of the built environment relates to patterns of human movement and spatial use. Developed by Hillier and Hanson (1984), the theory argues that urban movement is not distributed randomly but is partly shaped by the configurational properties of space, including accessibility, connectivity, and spatial integration. Rather than focusing solely on the physical characteristics of urban environments, space syntax examines the relational structure between spaces and how these relationships influence opportunities for movement, encounter, and co-presence within cities (Hillier, 2007). According to the theory of movement economy, spatially integrated environments tend to attract higher levels of pedestrian movement because they provide more accessible and intelligible routes within the urban system (Hillier et al., 1993). In this sense, the spatial configuration of streets and public spaces may correspond with the intensity and distribution of pedestrian activity. Space syntax therefore offers an analytical framework for investigating how the organization of urban space influences the ways people perceive, navigate, and use public environments.

2.2 Visibility theory

Visibility constitutes a central component of space syntax theory because the ways people perceive and visually access urban environments influence their movement decisions, navigations, and spatial behaviour. To examine these relationships, Turner et al. (2001) developed Visibility Graph Analysis (VGA), a method that evaluates the intervisibility of spaces and measures how visually connected different locations are within a spatial system. VGA enables the analysis of visual connectivity, spatial intelligibility, and visual integration by identifying how easily individuals can perceive surrounding areas from a given location. Previous studies suggest that visually connected and intelligible spaces tend to support easier orientation, improve spatial awareness, and correspond with higher levels of pedestrian movement (Penn, 2003; Natapov and Fisher-Gewirtzman, 2016). In contrast, spaces characterised by fragmented visibility or visual barriers may reduce the legibility of the environment and limit opportunities for movement and encounter. However, existing research generally identifies associations between configurational visibility and pedestrian activity rather than deterministic causal relationships, since human movement is also influenced by social, functional, and contextual factors beyond spatial configuration alone.

2.3 Public space vitality and visual accessibility

The relationship between visual accessibility and public space vitality has also been widely discussed in urban design and public life studies. Public spaces that provide clear visual connections, active edges, and open sightlines tend to encourage pedestrian presence, co-presence, and informal social interaction (Whyte, 1980; Gehl, 2011). Visibility contributes to the perception of accessibility and safety by allowing users to visually anticipate surrounding activities, movement paths, and potential destinations (Garau et al., 2026). In this sense, visually accessible environments may appear more inviting and easier to navigate, increasing the likelihood of pedestrian use and lingering activities. Conversely, visually concealed or spatially fragmented environments may reduce pedestrian attraction by limiting spatial awareness and weakening the relationship between public spaces and surrounding urban activities. The visual accessibility of public spaces is therefore closely related to their social performance, as it influences not only movement patterns but also the ways users perceive and experience urban environments.

2.4 Theoretical model

Although previous studies have examined the relationship between spatial visibility, configurational accessibility (Lamíquiz and López-Domínguez, 2015; Azadi et al., 2024; Liu, et al., 2025), and urban movement (Natapov and Fisher-Gewirtzman, 2016; Natapov et al., 2018; Zhou et al., 2026), relatively limited attention has been given to the comparative analysis of neighborhood public squares at the micro-urban scale, particularly in relation to visually underused spaces that provide similar physical amenities. Although existing research frequently focuses on larger urban systems (Kamalipour and Peimani, 2019) or general movement prediction (Natapov and Fisher-Gewirtzman, 2016)—whereas VGA is now widely employed to evaluate visual accessibility, movement potential, and socio-spatial behaviour (Turner et al., 2001; Van Nes and Yamu, 2021)—this study applies VGA not as a novel analytical technique, but as one component of an integrated methodological framework that combines configurational analysis with empirical pedestrian observation, isovist analysis, land-use assessment, and a comparative evaluation between two neighbourhood public squares. In addition, limited research has incorporated both internal visibility analysis through VGA and external visibility assessment through isovist analysis to examine how the visual relationship between public spaces and surrounding streets may influence patterns of urban use. Based on these theoretical foundations, the present study investigates whether differences in spatial configuration, visual permeability, and surrounding visibility conditions correspond with variations in pedestrian presence and movement patterns in neighborhood public squares. The suggested theoretical model has been clearly presented in Figure 1.

3 Materials and methods

This study adopts a quantitative research approach combining empirical observation with configurational spatial analysis to investigate the relationship between spatial visibility and pedestrian movement in urban squares. The research begins with an empirical observation method based on recording pedestrian presence and general behavioural activities within the squares at different times of the day, providing both quantitative and qualitative insight into patterns of spatial use within the case study areas. These observations offer an initial understanding of the patterns of activity and the differences in levels of use between the selected public spaces. Following this observational phase, a configurational spatial analysis is conducted based on space syntax theory using the software Depthmap10. Particularly, VGA is applied to evaluate visual connectivity and spatial accessibility within the selected squares, enabling the identification of areas with stronger spatial associations with pedestrian presence and movement patterns. To complement the configurational analysis, the study also incorporates a surrounding land use and activity analysis in order to examine the contextual urban characteristics adjacent to the squares, including commercial activities, active frontages, and surrounding pedestrian-oriented functions that may contribute to patterns of public space use. Finally, a comparative analysis is carried out to examine the differences between the two case studies by comparing VGA indicators, analysing the correlation between visual connectivity and integration, and evaluating the isovist visibility conditions of each square from the surrounding street network. The methodological framework is intended to identify spatial

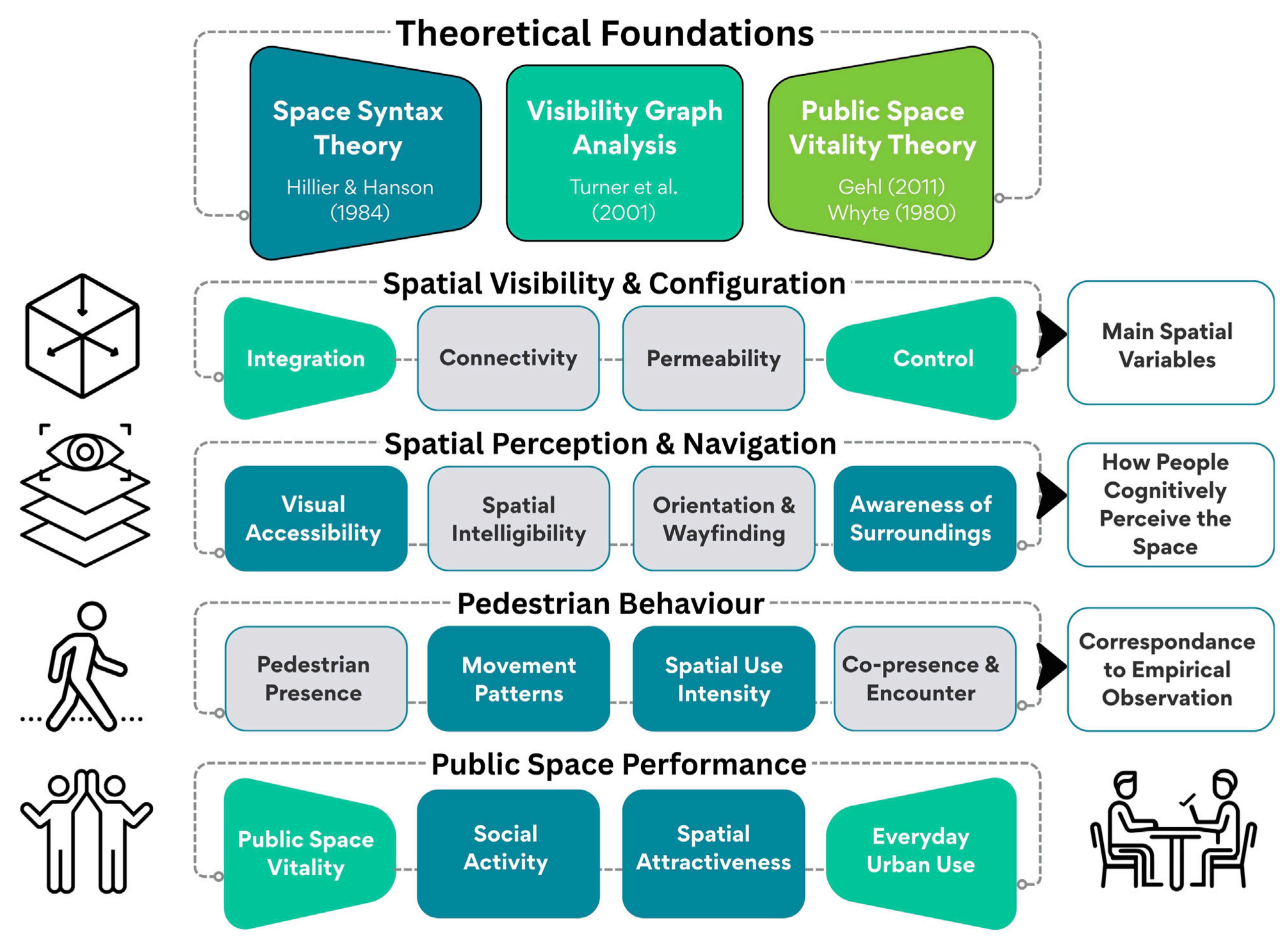


FIGURE 1
Theoretical framework shows the theoretical foundations shaping the theoretical model of this research.

associations and configurational relationships between visibility conditions and pedestrian presence rather than to establish deterministic causal relationships, since pedestrian activity may also be influenced by social, functional, and contextual urban factors beyond spatial configuration alone. The sequential phases of the research design have been clearly depicted in Figure 2.

3.1 Case study selection

The study focuses on Piazza Galileo Galilei and Piazza Michelangelo (Figure 3), two public squares located within the vicinity of San Benedetto district of Cagliari, Italy. Both squares are classified as neighbourhood public spaces that primarily serve the daily needs of local residents rather than functioning as city-wide civic or tourist destinations. They are surrounded by predominantly residential neighbourhoods with mixed commercial ground-floor activities, and provide comparable public amenities, including seating areas, greenery, pedestrian pathways, and public accessibility. These shared contextual characteristics make them suitable for comparative analysis. Although the two squares differ in their geometric form, edge configuration, commercial frontage, and immediate spatial context, these differences are precisely what make the comparison methodologically meaningful. Rather than comparing identical spaces, the study adopts a comparative case study approach in which two neighbourhood squares with similar urban functions and facilities but contrasting spatial configurations are examined to explore how variations in visibility structure, spatial integration, external visual permeability, and surrounding land-use patterns correspond with differences in pedestrian activity. By controlling broad neighbourhood function while allowing configurational differences to vary, the comparison provides a robust basis for investigating the relationship between spatial characteristics and observed patterns of public-space use.

3.2 Empirical observation

To provide empirical evidence of actual pedestrian presence, this study employs a structured observational method based on counting pedestrians within the square areas. Empirical observation is commonly used in urban design and space syntax studies to capture real patterns of human activity and to compare them with spatial predictions derived from configurational analysis (Karimi, 2023). In this research, pedestrian counting was used to measure the number of individuals present within each square at specific time periods, providing a direct quantitative indication of the level

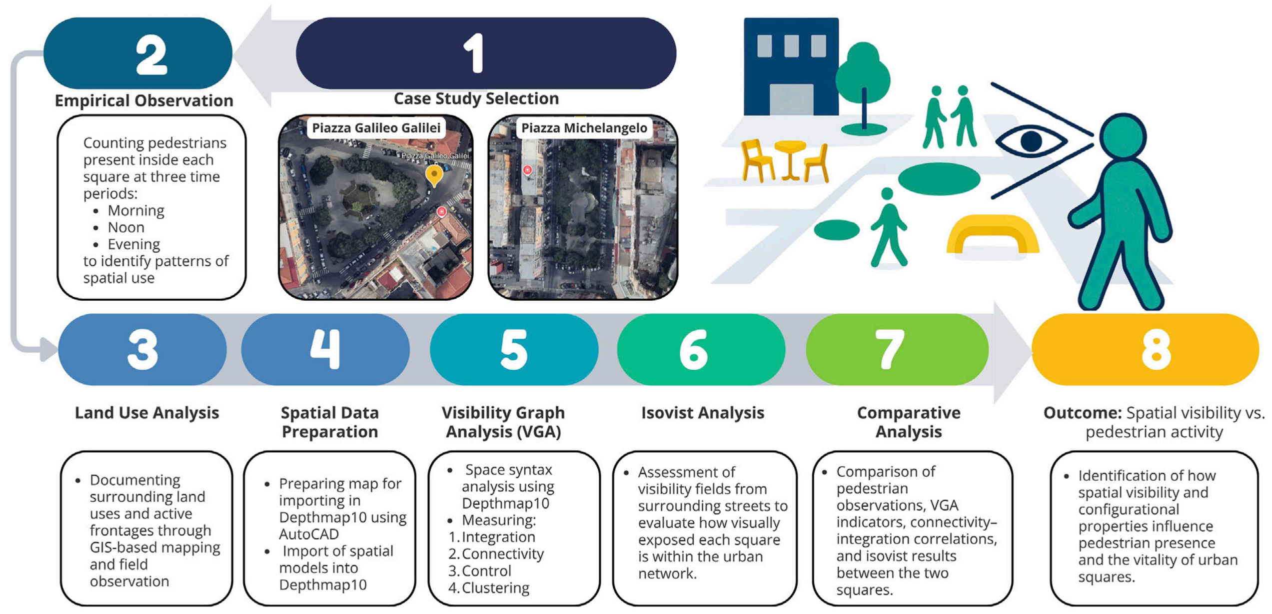


FIGURE 2
Methodological framework of the study illustrating the sequential workflow.

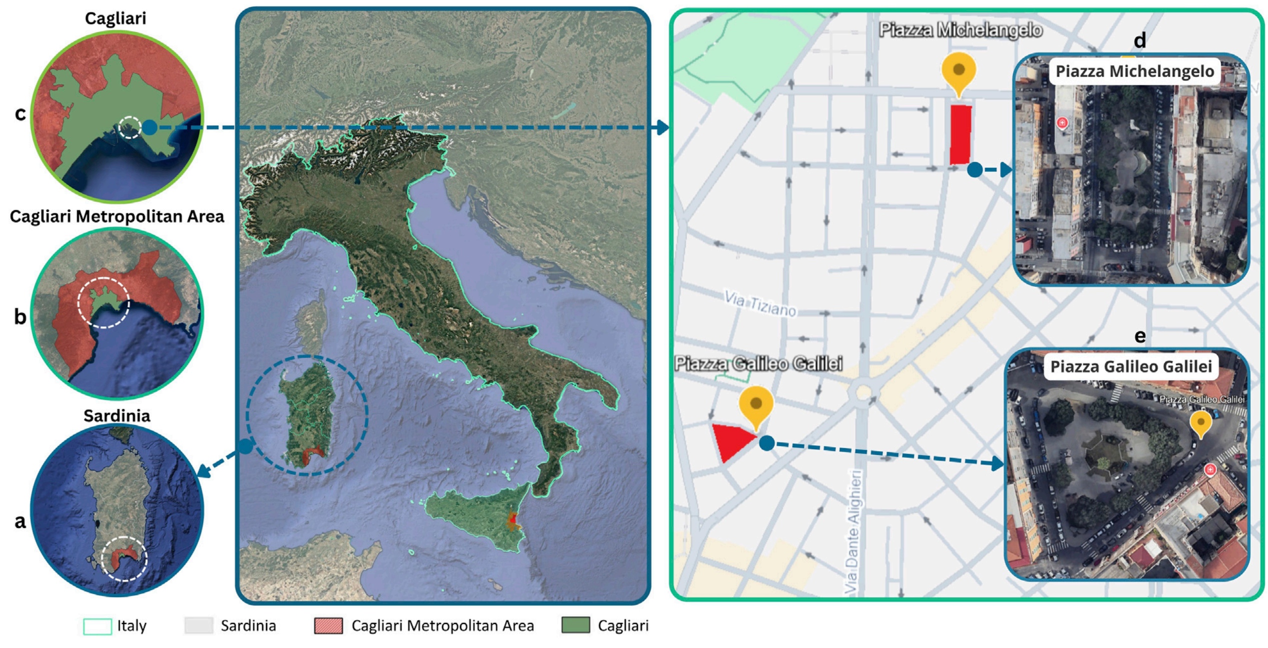


FIGURE 3
Geographic context and location of the case study sites. **(a)** The island of Sardinia in Italy, **(b)** the Cagliari Metropolitan Area, **(c)** the city of Cagliari, and the detailed locations of the two study squares: **(d)** Piazza Michelangelo and **(e)** Piazza Galileo Galilei in the San Benedetto district.

of use of the public spaces. Unlike traditional gate count methods, which record pedestrian flows across predefined observation lines, the relatively small spatial dimensions of the two case study squares made it more appropriate to record the number of pedestrians present within the entire square area. This approach allows the study to capture overall activity levels and the spatial distribution of people inside the squares rather than only measuring movement through specific access points.

Observations were conducted in both case study squares across three distinct daily periods—morning, noon, and evening—to capture variations in pedestrian presence throughout the daily cycle. The fieldwork for Piazza Galileo Galilei and Piazza Michelangelo was carried out on two separate weekdays under comparable seasonal conditions. While minor differences in temperature and cloud cover occurred between the observation days, both surveys took place during stable weather without rainfall or extreme climatic events, ensuring comparable environmental baselines. Both observation days were selected during regular working weeks and did not coincide with public holidays, special events, or temporary activities that could substantially alter normal pedestrian patterns. During each interval, the total number of pedestrians within the square was recorded, and their precise locations were mapped to analyze spatial distribution patterns. This approach provides both quantitative data on pedestrian presence and spatial insight into how different areas of the squares are used. Although the observational method provides direct evidence of pedestrian presence and spatial occupation patterns, it does not independently determine the specific causal factors underlying pedestrian behaviour but rather allows comparison between observed activity patterns and spatial visibility conditions identified through configurational analysis.

The observational strategy was designed to provide comparable snapshots of pedestrian activity rather than continuous monitoring over extended periods. Three observation sessions representing morning, midday, and evening were selected to capture the principal phases of daily public-space use commonly adopted in behavioural studies. Because the primary objective of this research is to compare two neighbourhood squares under broadly comparable conditions rather than to quantify long-term temporal variability, the same observation protocol was consistently applied to both case studies. While repeated observations over multiple weekdays and weekends could provide additional insights into temporal fluctuations, such an approach was beyond the scope of the present study.

In addition to recording pedestrian presence, the observational process also included qualitative behavioural assessment of the activities occurring within the squares during each observation period. Particular attention was given to identifying recurring patterns of use, including passing, and lingering. These observations were documented through field notes and spatial mapping in order to provide a broader understanding of how the public spaces were being used beyond simple pedestrian counts. Although the behavioural observations were not quantified through detailed behavioural coding techniques, they provided complementary contextual evidence for interpreting the differences in activity patterns observed between the two case study squares.

To improve the comparability of pedestrian activity between the two case study squares, pedestrian observations were also normalised by the usable pedestrian area of each square (pedestrians per 100 m^2). Pedestrian density was calculated by dividing the observed number of pedestrians during each observation period by the usable pedestrian area (pedestrians/m^2), and average density values were subsequently derived for each square. This normalisation accounts for differences in the physical dimensions of the public spaces, allowing pedestrian activity to be compared independently of square size. Accordingly, pedestrian density provides a more robust indicator of spatial intensity than raw pedestrian counts alone and supports a more meaningful comparison of public-space use between the two case studies.

3.3 Spatial data preparation

To conduct the configurational analysis, spatial data of the case study areas were first collected and prepared for processing in the Depthmap10 software environment. The raw spatial maps were obtained from the digital cartography archive available on the official website of the municipality of Cagliari. These maps provided the base geographic information of the study area, including street layouts, square boundaries, and surrounding urban structures. Before performing the visibility analysis, the maps required preprocessing to ensure compatibility with space syntax analysis tools. The spatial data were therefore imported into AutoCAD 2026, where the base maps were cleaned and simplified to generate an accurate representation of the spatial layout relevant to the study. This preparation process involved several steps, including creating a clean street network and square layout, removing unnecessary graphical elements, and ensuring topological correctness of the spatial network so that paths and boundaries were properly connected and represented. In addition, the spatial files were adjusted to meet the formatting requirements of the Depthmap10 software. This included verifying the geometric consistency of the drawing and exporting the finalized spatial layouts in DXF format, which is compatible with Depthmap10 for performing configurational and visibility analyses. This preprocessing step ensures that the spatial data accurately represents the physical structure of the case study squares and their surrounding environment before conducting the VGA.

3.4 Surrounding land use and activity analysis

In addition to configurational visibility analysis, the study considers the surrounding urban context of the selected squares in order to account for the potential contribution of adjacent land uses and urban activities to pedestrian presence. Urban design literature has shown that active frontages, commercial functions, cafés, and mixed-use environments may contribute to higher levels of pedestrian activity and public space use by increasing opportunities for movement, visibility, and social interaction (Gehl, 2011; Jacobs, 1961). Therefore, examining the surrounding urban context is important for avoiding an overly deterministic interpretation of configurational visibility measures alone. The surrounding land uses and activity conditions of both case study squares were examined through direct field observation and visual survey. This analysis focused on identifying the predominant urban functions adjacent to the squares, including commercial activities, cafés, retail uses, residential frontages, and pedestrian-oriented urban services. In addition, the degree of activity along the surrounding street edges and the presence of active frontages were comparatively observed to better contextualize differences in pedestrian presence between the two public spaces.

Rather than functioning as an independent predictive analysis, the surrounding land use assessment serves as a complementary contextual layer that supports the interpretation of the VGA and observational findings. This approach allows the study to consider pedestrian presence as the result of multiple interacting spatial and urban conditions rather than attributing public space use exclusively to configurational visibility properties. To support the contextual analysis, surrounding land uses and active frontages were spatially documented through GIS-based mapping and field observation. The land-use maps illustrate the predominant urban functions surrounding each square, including commercial activities, cafés, residential uses, and public services, while also identifying active pedestrian-oriented edges adjacent to the public spaces. This visual mapping approach enables a comparative understanding of the surrounding urban context and provides an additional analytical layer for interpreting differences in pedestrian presence beyond configurational visibility conditions alone.

3.5 Visibility Graph Analysis (VGA)

VGA is a space syntax–based analytical technique used to examine the visual structure of spatial environments and evaluate how visual permeability influence movement and spatial behavior (Van Nes and Yamu, 2021). VGA represents space as a grid of intervisible points and calculates how each location within a space can visually connect with other locations (Turner et al., 2001). By measuring visual connectivity and visual integration, the method allows researchers to identify areas with greater visual accessibility and potential for pedestrian movement. In urban public spaces, locations with higher visual integration tend to be more vibrant and easier to navigate, often attracting higher levels of pedestrian behavioural activity and social interaction (Askarizad et al., 2025).

In this study, VGA was conducted using Depthmap10 software to analyse the visual structure of the selected urban squares. The spatial layouts of the squares and their immediate surroundings were first digitised and imported into the software environment. A grid-based visibility analysis was then generated to compute the visual relationships between all accessible points within the study area. The resulting maps illustrate the distribution of visibility values across the squares, typically represented through a colour spectrum in which warmer colours (red and orange) indicate areas with higher visual integration and connectivity, while cooler colors (blue and green) represent spaces with lower visibility and weaker visual connections.

Through this analysis, VGA helps identify how spatial elements such as trees, street furniture, pathways, and surrounding buildings influence the visual permeability of the squares. By revealing areas with stronger or weaker visual connections, the method provides insights into how spatial visibility may support or constrain pedestrian movement and spatial awareness within the public spaces. The results of the VGA therefore serve as an important analytical basis for understanding the relationship between spatial visibility and pedestrian mobility in the selected case studies. Consequently, VGA primarily identifies configurational relationships and spatial associations between visibility conditions and pedestrian presence rather than direct causal effects, as pedestrian activity in public spaces may also be shaped by land use, surrounding urban functions, social behaviour, and temporal variations.

3.6 Isovist visibility analysis

This study also employs isovist Visibility Analysis to examine the visual permeability and exposure of the case study squares from the surrounding street network. In the context of space syntax, visual permeability refers to the extent to which a person's line of sight can penetrate through a physical environment, determining the degree of spatial transparency and the potential for surveillance or wayfinding within a layout (Moosavi et al., 2025). In this regard, an isovist represents the field of vision from a specific observation point in space, illustrating the extent of the area that can be visually perceived from that location without obstruction (Hillier and Iida, 2005). In urban spatial analysis, isovists are frequently used to evaluate how visible a space is from its surroundings and how this visibility may correspond with spatial perception, accessibility, permeability, and pedestrian presence (Vaughan, 2007). In this research, isovist analysis was conducted by selecting several observation points along the streets surrounding each square, representing the typical viewpoints of pedestrians approaching the space from adjacent urban routes. From each observation point, the visible field toward the square was generated, allowing the assessment of whether the square is visually accessible or concealed from the surrounding street network. This approach provides insight into the external visual permeability of the public spaces, which may correspond with differences in pedestrian visibility, awareness, and spatial use.

3.7 Axial map analysis

To complement the visibility-based analyses conducted within the public squares, an axial integration analysis was performed to evaluate the configurational properties of the surrounding street network at the neighbourhood scale. While VGA examines visual accessibility within individual public spaces, axial analysis assesses how streets are integrated within the wider urban system based on space syntax theory (Hillier and Hanson, 1984). This provides an indication of the relative accessibility of each square within the surrounding movement network. In this study, the axial map of San Benedetto and its adjacent neighbourhoods was analysed using Depthmap10 software. Among the available configurational measures, Integration (HH) R2 was selected because it represents local spatial integration, reflecting how well each street segment is connected within its immediate urban context. The analysis was used to compare the local integration values of the street segments adjacent to Piazza Galileo Galilei and Piazza Michelangelo. Rather than explaining pedestrian activity independently, the axial analysis provides complementary wider-scale context for interpreting the results of the empirical observations and the visibility analyses.

3.8 Comparative analysis

Following the observational and spatial analyses, a comparative analysis was conducted to identify and interpret the differences between the two case study squares. The purpose of this stage was to examine how variations in spatial configuration and visibility conditions correspond with the observed differences in pedestrian presence and spatial use. By systematically comparing the analytical outputs of the two squares, the study aims to provide a clearer understanding of the relationship between spatial structure

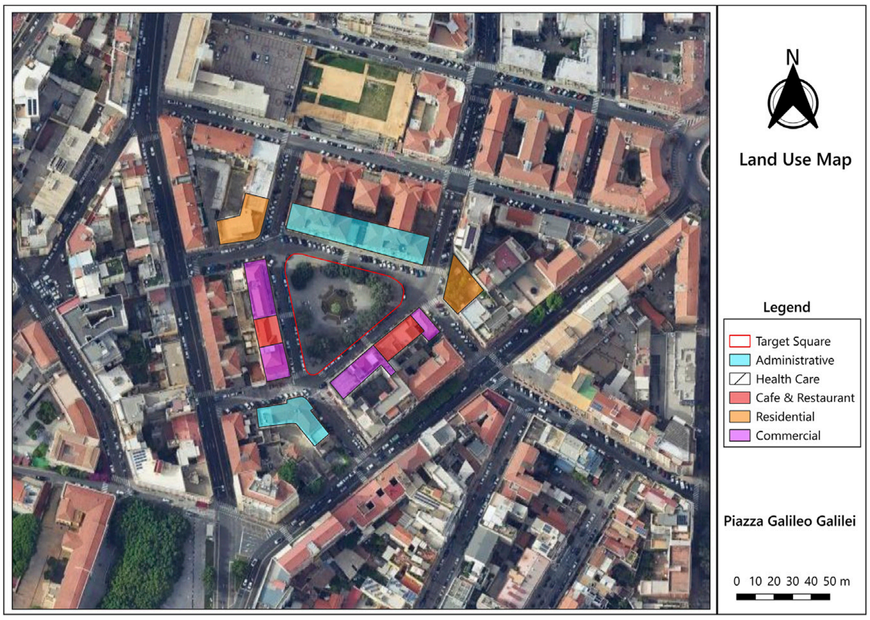


FIGURE 4
Land use distribution and urban functional mix surrounding Piazza Galileo Galilei, highlighting a triangular public space enclosed by a combination of administrative zones, active commercial perimeters, and integrated catering services.

and the performance of public urban spaces. Rather than establishing direct causality, the comparative approach is intended to identify consistent spatial associations between configurational visibility conditions and observed pedestrian presence across the two case study squares.

The comparison was carried out using several complementary indicators derived from the analyses. First, the results of the empirical pedestrian observations were compared across the two squares to highlight variations in pedestrian presence and spatial distribution patterns. Next, the VGA metrics, including visual connectivity, visual integration (HH), visual control, and visual clustering coefficient, were compared between the two squares to identify differences in their internal visibility structures. In addition, the correlation between visual connectivity and visual integration was examined for each square through scatter plot analysis in order to evaluate the correlation between the visual integration and connection properties within the spatial system. Furthermore, the Isovist visibility analysis was used to compare the degree to which each square is visually exposed from the surrounding street network.

The surrounding land use and activity observations were also comparatively evaluated to identify differences in commercial activity, active frontages, and surrounding urban functions adjacent to the squares. This comparison allowed the study to assess differences in external visual accessibility and how easily the squares can be perceived by pedestrians approaching from nearby streets.

4 Results

This section presents the results of the empirical observations and spatial analyses conducted for the two case study squares. The analysis begins with the results of the gate count observations in order to establish the existing patterns of pedestrian movement within the squares. These empirical findings provide the basis for comparing the spatial performance of the two public spaces and for identifying differences in their levels of pedestrian activity. The subsequent sections then examine the spatial visibility structure of the squares through VGA, including visual integration, visual connectivity, visual clustering coefficient, and visual control. In addition, the relationship between connectivity and integration is explored through correlation analysis, while isovist analysis is used to illustrate the visual perception of spaces. All in all, these analyses help explain how spatial visibility conditions may influence pedestrian mobility in the case study squares.

4.1 Land use mapping

The land use analysis of Piazza Galileo Galilei presented in Figure 4, reveals a relatively mixed urban context characterized by the coexistence of commercial, residential, administrative, healthcare, and food-related functions surrounding the square. Commercial activities are mainly concentrated along the southern and western edges of the square, while cafés and restaurants are positioned on the eastern frontage, contributing to localized pedestrian attraction points. Administrative functions are distributed primarily along the northern edge, whereas residential buildings are located more intermittently around the surrounding streets. Although the square benefits from a diversity of land uses, many of these activities appear spatially fragmented and unevenly distributed around the perimeter. In particular, several edges of the square are bordered by inactive or less visually engaging frontages, reducing the continuity of pedestrian-oriented activity around the space. Furthermore, the triangular geometry of the

FIGURE 5
Land use distribution and urban functional mix surrounding Piazza Michelangelo, illustrating a linear, symmetrical street layout characterized by a distinct spatial separation between a commercial-hospitality spine and residential-healthcare sectors.

square and the irregular arrangement of surrounding buildings contribute to a less coherent relationship between adjacent functions and pedestrian movement routes. As a result, despite the presence of multiple urban functions, the surrounding land use pattern provides relatively discontinuous activity support and limited visual attraction toward the interior of the square.

In contrast, the land use pattern surrounding Piazza Michelangelo (Figure 5) demonstrates a more linear and concentrated distribution of active urban functions. Commercial activities and cafés are strongly aligned along the eastern frontage of the square, creating a continuous edge of pedestrian-oriented uses directly facing the public space. Additional commercial and residential functions are also located at the southern and western sides, reinforcing the integration of the square within the surrounding neighborhood movement network. Integrated cleanly into its residential block is a dedicated healthcare facility, adding a layer of essential public infrastructure to the neighborhood fabric. Compared to Piazza Galileo Galilei, the arrangement of land uses around Piazza Michelangelo appears more compact and spatially connected, with active frontages directly exposed to the square and adjacent streets. This configuration increases both visual interaction and functional accessibility between indoor activities and outdoor public space. Moreover, the elongated rectangular form of the square allows clearer visual exposure from the surrounding streets and facilitates stronger continuity between pedestrian movement paths and surrounding activities. The concentration of active uses along the perimeter therefore contributes to a more visible and spatially integrated urban environment, supporting higher levels of pedestrian presence and everyday public activity within the square. Notably, this study area completely lacks the prominent administrative zones observed in the previous map, shifting its functional identity entirely toward commerce and local living. The rigid geometry of the street layout enhances the clear division between these active retail fronts and the residential spaces.

4.2 Pedestrian movement patterns

The results of the pedestrian observation conducted in Piazza Galileo Galilei are presented in Figure 6, illustrating both the spatial distribution of pedestrians and the variation of activity patterns across three observation periods: morning (10:30), noon (13:30), and evening (19:00). In addition to recording the total number of pedestrians present within the square, the observation also distinguished between two behavioural activity categories: passing pedestrians and lingering pedestrians. Passing refers to individuals moving through the square without remaining in the space for an extended period, whereas lingering refers to users who temporarily stay within the square for activities such as sitting, standing, resting, or social interaction. The spatial locations of observed pedestrians are represented on the map using coloured points corresponding to the different observation periods, while the accompanying bar chart summarises the total pedestrian count together with the distribution of passing and lingering activities.

The results reveal relatively modest levels of pedestrian activity during the daytime hours, with a noticeable increase during the evening period. At 10:30, a total of eight pedestrians were observed within the square, including five lingering users and three passing pedestrians. During the noon observation at 13:30, the number slightly decreased to seven pedestrians, with movement-oriented activities becoming more dominant, as five pedestrians were recorded as passing through space and only two were lingering. The evening observation at 19:00 demonstrates the highest level of activity, with fourteen pedestrians present within the square,

Time	Pedestrian Caunt	Passing	Lingering	Weather
10:30	8	3	5	Cloudy, 14°C
13:30	7	5	2	Sunny, 16°C
19:00	14	5	9	Cloudy, 12°C

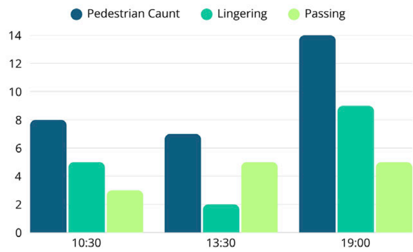
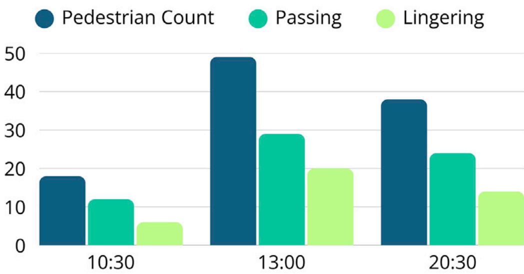


FIGURE 6
Pedestrian observation results in Piazza Galileo Galilei illustrates the spatial distribution of pedestrians observed inside the square at three different times of the day: morning (10:30), noon (13:30), and evening (19:00). Coloured points indicate the location of pedestrians during each observation period. The accompanying bar chart summarises the total number of pedestrians recorded at each time interval.

Time	Pedestrian Count	Passing	Lingering	Weather
10:30	18	12	6	Cloudy, 12°C
13:00	49	29	20	Cloudy, 15°C
20:30	38	24	14	Dark, 10°C



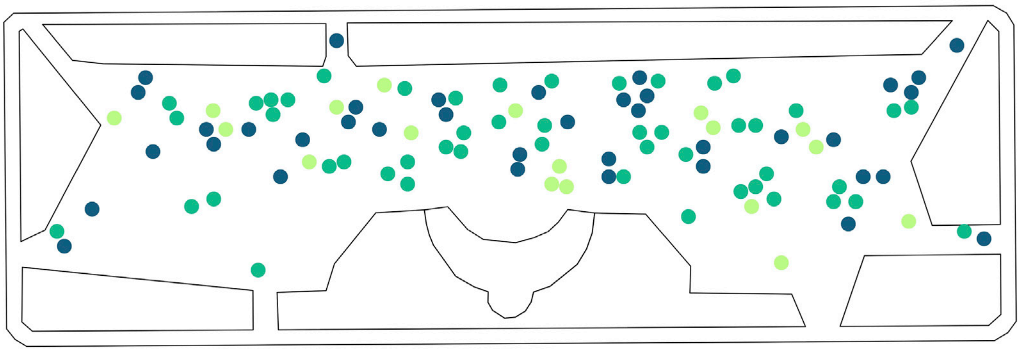


FIGURE 7
Pedestrian observation results in Piazza Michelangelo shows the spatial distribution of pedestrians observed inside the square at three different times of the day: morning (10:30), noon (13:00), and evening (20:30). Coloured spots represent the location of pedestrians during each observation period, while the bar chart summarises the total number of pedestrians recorded at each time interval.

including nine lingering users and five passing pedestrians. This increase in lingering behaviour during the evening suggests that the square becomes relatively more socially active during later hours of the day.

The spatial distribution of pedestrians also reveals a distinct pattern of use within the square. Most users tend to concentrate along the perimeter pathways and near the edges of the square, while the central internal areas remain comparatively underused. Lingering activities are primarily located near shaded seating areas and along visually accessible edges, whereas passing movements generally follow the peripheral circulation routes. The limited use of the central space may indicate that the spatial configuration and visibility structure of the square do not strongly encourage prolonged occupation within the interior zones. Overall, the observational findings suggest that Piazza Galileo Galilei functions more as a transitional and edge-oriented public space than as a highly active social gathering environment. These results provide an empirical basis for the subsequent configurational and visibility analyses, which aim to examine how spatial visibility and visual permeability may correspond with the observed patterns of pedestrian presence and activity.

The results for Piazza Michelangelo (Figure 7), reveal considerably higher levels of pedestrian presence and activity compared to Piazza Galileo Galilei. In addition to recording the total number of pedestrians present within the square, the observation distinguished between two behavioural activity categories: passing and lingering. During the morning observation at 10:30, a total of 18 pedestrians were recorded within the square, including 12 passing pedestrians and 6 lingering users. The number increased significantly at 13:00, when 49 pedestrians were observed, representing the highest level of activity during the day. At this time, 29 pedestrians were categorized as passing through space, while 20 users were engaged in lingering activities. During the evening observation at 20:30, the total number of pedestrians slightly decreased to 38 users, consisting of 24 passing pedestrians and 14 lingering users. Despite this decrease, the square maintained a relatively high level of use during the evening period.

The spatial distribution of pedestrians within the square demonstrates a relatively even dispersion across the central open area, with many users occupying the main circulation corridor extending along the length of the square. Passing activities are strongly concentrated along the central linear pathway, indicating that the square functions as an important pedestrian movement corridor within the surrounding urban network. At the same time, lingering activities are also distributed across visually open and accessible areas of the square, particularly near seating zones and shaded spaces. Unlike Piazza Galileo Galilei, where activities were concentrated primarily along the edges, Piazza Michelangelo exhibits a more active use of its internal central space. This distribution pattern suggests that the unobstructed spatial layout and stronger visual continuity of the square encourage both movement and temporary occupation of the space.

To account for differences in the size of the two case study squares, pedestrian observations were normalised by the usable pedestrian area. Piazza Galileo Galilei exhibited an average pedestrian density of 0.40 pedestrians per 100 m^2, whereas Piazza Michelangelo reached 1.32 pedestrians per 100 m^2. Thus, even after accounting for differences in usable area, Piazza Michelangelo accommodated approximately 3.3 times greater pedestrian density than Piazza Galileo Galilei. These findings indicate that the higher pedestrian activity observed in Piazza Michelangelo cannot be explained solely by its physical dimensions but reflects a more intensive use of the available public space.

Overall, the observation results indicate that Piazza Michelangelo experiences substantially higher pedestrian activity and a more dynamic pattern of spatial use compared to Piazza Galileo Galilei. The coexistence of both movement-oriented and lingering activities suggests that the square functions not only as a transitional route but also as an active social environment supporting temporary stay and interaction. These findings provide an empirical basis for the subsequent spatial analyses, which investigate whether the stronger visibility structure, greater visual permeability, and clearer spatial configuration of the square contribute to its higher levels of pedestrian mobility and social activity.

4.3 Visibility Graph Analysis (VGA)

The visual integration results (Figure 8) for Piazza Galileo Galilei indicate how visually accessible each location within the square is relative to the entire spatial system. Warmer colours (yellow–orange) dominate the central circulation area, suggesting that these pathways are visually accessible from multiple parts of the space and support spatial orientation. In contrast, cooler colours (green–blue) appear along the peripheral edges and near built structures, indicating lower visual accessibility.

The visual connectivity graph shows the number of directly visible spaces from each location. Higher connectivity values are concentrated along the outer pedestrian paths and edges of the triangular square, where wider immediate visibility facilitates movement decisions. Lower connectivity values appear near buildings and corner spaces, where physical elements restrict visual fields. The visual clustering coefficient measures the extent to which visually connected spaces are also connected to one another, reflecting higher potential for static behavioural activities. Higher clustering values appear mainly around the circular central structure, indicating locally cohesive visual environments. In contrast, the outer triangular edges show lower clustering values, suggesting more fragmented visual relationships along the boundaries. The visual control map represents how much a location visually controls surrounding spaces. Higher control values occur along certain edge corridors and transition zones between pathways, where these locations function as visual gateways within the square. The central area shows moderate control values, indicating a more evenly distributed visual field.

Together, the integration, connectivity, clustering, and control graphs suggest that pedestrian movement in Piazza Galileo Galilei is likely to concentrate along the accessible pathways near the edges of the square rather than in the corner areas. These perimeter paths exhibit the highest levels of visual accessibility and intervisibility, making them more legible and attractive for movement, while the corners remain comparatively less connected and spatially prominent. Overall, the VGA results indicate that the spatial configuration of the square supports movement primarily along the perimeter circulation paths, while the corner zones remain relatively less visible and less integrated within the spatial system.

Figure 9 presents the VGA results for Piazza Michelangelo, illustrating the spatial distribution of four configurational indicators: visual integration, visual connectivity, visual clustering coefficient, and visual control. These indicators help explain how the spatial structure of the square influence visual accessibility, spatial perception, and potential pedestrian movement.

The visual integration map shows how visually accessible each point in the square is relative to the overall spatial system. Higher integration values (red–orange) appear mainly along the central longitudinal axis, particularly near the main pedestrian entrances, indicating that this corridor shapes the most visually accessible part of the square. Lower integration values (green–blue) occur along the peripheral edges and near built structures, suggesting weaker visual connections with the overall spatial system. The visual connectivity map illustrates the

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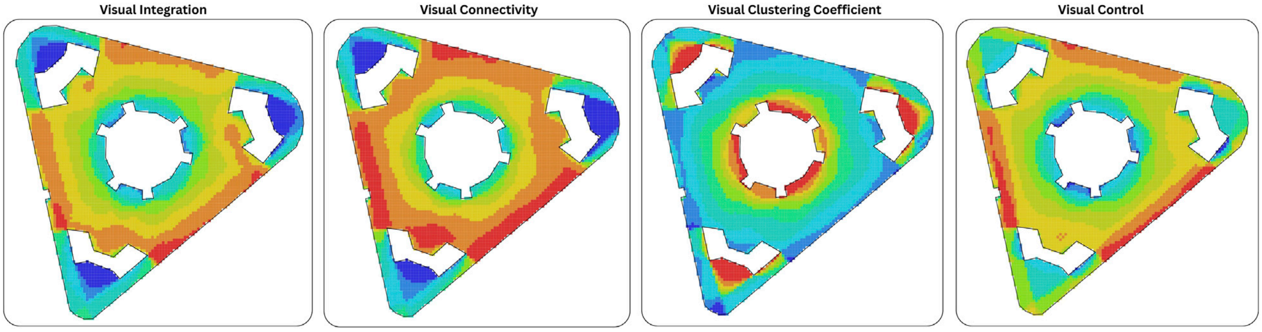

FIGURE 8
VGA results for Piazza Galileo Galilei showing spatial patterns of visual integration, visual connectivity, visual clustering coefficient, and visual control.

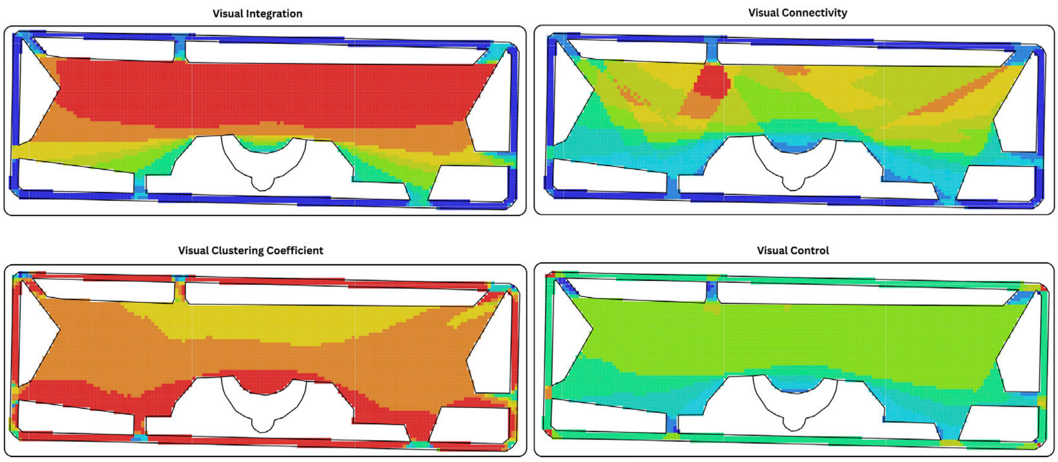

FIGURE 9
VGA results for Piazza Michelangelo showing spatial patterns of visual integration, visual connectivity, visual clustering coefficient, and visual control.

number of immediately visible spaces from each location. Very high connectivity values appear across the central open area, indicating that pedestrians in this corridor can visually access a large portion of the surrounding space. Lower connectivity values occur near the edges and architectural boundaries, where built elements and vegetation restrict the visual field. The visual clustering coefficient reflects the degree of local visual pause points. In Piazza Michelangelo, higher clustering values appear mainly along the edges and boundary zones, indicating stronger local visual relationships between adjacent spaces. In contrast, the central area shows moderate clustering values, suggesting that its visual connections extend across the broader spatial system rather than forming tightly connected local clusters. The visual control map indicates how much a location visually controls surrounding spaces. Moderate control values dominate the central circulation corridor, while lower control values appear near the edges and recessed spaces where visibility is more constrained.

Overall, the VGA results suggest that Piazza Michelangelo is structured around a strong central visibility corridor, where both visual integration and connectivity are relatively high. This central axis functions as the primary visual and movement areas within the square, while the peripheral zones remain comparatively less integrated within the spatial system.

4.4 Axial map analysis of the surrounding street network

Figure 10 presents the Integration (HH) R2 axial map of San Benedetto and adjacent neighbourhoods. The analysis indicates that both public squares are located within relatively well-integrated parts of the local street network, although their levels of local integration differ slightly. Piazza Galileo Galilei records a higher Integration (HH) R2 value (3.3175) than Piazza Michelangelo (2.7492), while both squares display identical connectivity values (Connectivity = 5). At the neighbourhood scale, these results suggest that Piazza Galileo Galilei occupies a slightly more locally integrated position within the surrounding street network.

However, this configurational pattern contrasts with the empirical observations. Despite its higher local integration value, Piazza Galileo Galilei consistently recorded lower pedestrian density, fewer lingering activities, and lower overall levels of

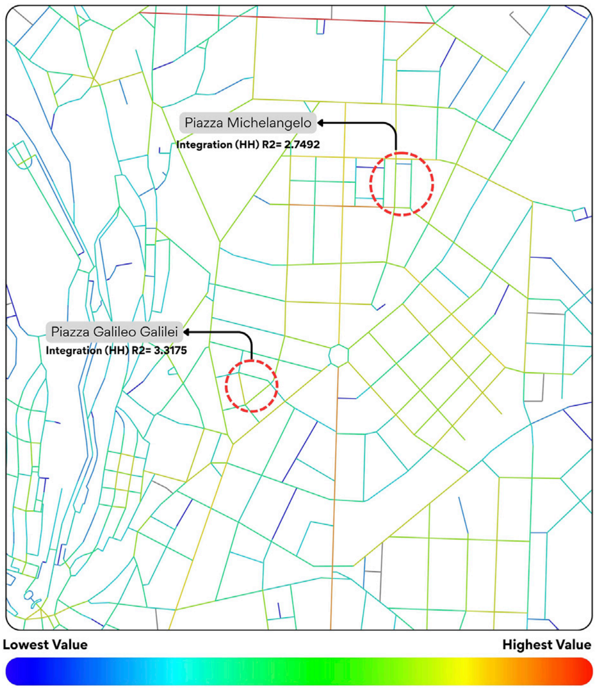

FIGURE 10
Axial map of the San Benedetto district displaying Integration (HH) R2 values. Warmer colours indicate streets with higher levels of global spatial integration, while cooler colours represent lower levels of integration.

public-space use than Piazza Michelangelo. This finding indicates that higher local street integration alone does not necessarily translate into greater pedestrian activity within public squares. Instead, the results suggest that neighbourhood-scale accessibility should be interpreted together with the internal visibility structure, visual permeability, surrounding land-use characteristics, and environmental qualities of the public space.

4.5 Comparative analysis of the two squares

To better understand the differences in pedestrian presence between the two case study squares, a comparative analysis was conducted by examining the observation results together with the spatial visibility indicators derived from the VGA. Although Piazza Galileo Galilei and Piazza Michelangelo are both neighborhood public spaces that provide comparable facilities such as seating areas, greenery, and pedestrian access, the empirical observations reveal a clear difference in their levels of use. As illustrated in Figure 11, pedestrian activity in Piazza Galileo Galilei remains relatively low throughout the day, with 8 pedestrians recorded in the morning, 7 at noon, and 14 in the evening. In contrast, Piazza Michelangelo shows significantly higher levels of activity, with 18 pedestrians observed in the morning, a peak of 49 at noon, and 38 in the evening. Figure 7 highlights this strong contrast, particularly during the midday period when Piazza Michelangelo attracts the highest concentration of pedestrians, while the line chart further illustrates the differing daily patterns between the two spaces. While Piazza Galileo Galilei shows only a slight increase in use toward the evening, Piazza Michelangelo experiences a pronounced midday peak followed by a moderate decline later in the day. These results confirm that Piazza Michelangelo functions as a considerably more active public space, whereas Piazza Galileo Galilei maintains comparatively limited pedestrian use. In the following analysis, the spatial characteristics of the two squares, particularly visual integration, connectivity, clustering coefficient, and visual control, are compared in order to examine how differences in spatial visibility and configuration may help explain these contrasting levels of pedestrian activity.

The comparison of pedestrian activities between the two case study squares reveals notable differences not only in the overall number of users but also in the nature of spatial use. Piazza Michelangelo consistently indicated substantially higher levels of both passing and lingering activities throughout all observation periods. In Piazza Galileo Galilei, pedestrian behaviour was dominated by relatively low-intensity movement patterns, with passing activities remaining limited and lingering activities concentrated mainly during the evening period. For instance, the highest recorded lingering activity in Piazza Galileo Galilei was nine users during the evening observation, whereas Piazza Michelangelo recorded twenty lingering users during the midday observation alone. Similarly, passing activities in Piazza Michelangelo reached twenty-nine pedestrians at 13:00, significantly exceeding the maximum of five passing pedestrians observed in Piazza Galileo Galilei. These findings suggest that Piazza Michelangelo functions simultaneously as both a movement corridor and a destination space that encourages temporary stay and social interaction. In contrast, Piazza Galileo Galilei appears to operate more as a peripheral transitional environment with weaker capacity to attract prolonged occupation. The comparison therefore displays that differences in spatial visibility, openness, and configurational structure may influence not only the intensity of pedestrian presence but also the type of activities occurring within public spaces.

The comparison of the maximum values of the visibility indicators further highlights the spatial differences between the two squares. As shown in Table 1, Piazza Michelangelo shows higher maximum values in all selected indicators, including visual connectivity, visual integration (HH), visual clustering coefficient, and visual control. The maximum connectivity value in Piazza Michelangelo (3787) is considerably higher than that of Piazza Galileo Galilei (2746), indicating that certain locations in Piazza Michelangelo provide broader immediate visibility to surrounding spaces. Similarly, the maximum visual integration value is substantially higher in Piazza Michelangelo (46.55) compared to Piazza Galileo Galilei (20.02), suggesting stronger global visual accessibility within the square. The maximum visual control value is also higher in Piazza Michelangelo (1.9686) than in Piazza Galileo Galilei (1.4568), indicating the presence of spatial positions that visually control a larger portion of the surrounding environment. Finally, the visual clustering coefficient reaches slightly higher values in Piazza Michelangelo, reflecting stronger local visual relationships between adjacent spaces. Overall, these results indicate that Piazza Michelangelo contains spatial locations with significantly stronger visibility properties, which may contribute to its higher levels of pedestrian presence observed during field observations.

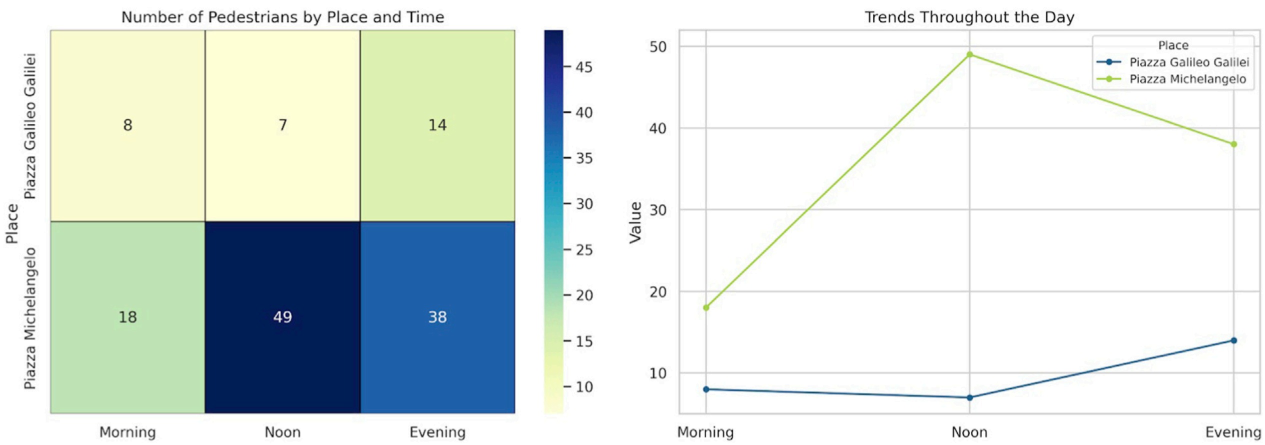

FIGURE 11
Comparative analysis of pedestrian presence in Piazza Galileo Galilei and Piazza Michelangelo across different times of the day.

TABLE 1 Comparison of maximum values of selected spatial visibility indicators between Piazza Galileo Galilei and Piazza Michelangelo derived from VGA.

Indicator	Piazza galileo galilei (max)	Piazza michelangelo (max)
Visual connectivity	2,746	3,787
Visual integration (HH)	20.0201	46.5501
Visual control	1.4568	1.9686
Visual clustering coefficient	0.9992	1.0000

The scatter plots (Figure 12) comparing visual integration and visual connectivity reveal a strong positive relationship in both squares, indicating that locations with higher overall visual accessibility also tend to have higher immediate visibility to surrounding spaces. In Piazza Galileo Galilei, this relationship is extremely strong and almost linear, with an R^2 value of 0.971, suggesting a highly consistent correspondence between connectivity and integration across the square. In Piazza Michelangelo, the relationship also remains strong, with an R^2 value of 0.839, but the distribution of points is more curved and dispersed, indicating a more varied visibility structure. This means that although both squares show a clear association between local and global visual properties, Piazza Galileo Galilei shows a more uniform and predictable spatial structure, whereas Piazza Michelangelo demonstrates a more differentiated spatial configuration with a wider range of integration and connectivity values. The lower R^2 in Piazza Michelangelo does not indicate weaker spatial performance; rather, it reflects a more complex visibility system, which may support a richer variety of spatial experiences and help explain its higher levels of pedestrian presence.

The isovist analysis further illustrates the differences in visual accessibility between the two squares from the surrounding street network. As shown in Figure 13, the visibility fields generated from observation points located along the adjacent streets indicate that Piazza Galileo Galilei has limited visual exposure from its surrounding urban environment. From most of the nearby streets, the interior of the square remains visually obstructed by surrounding buildings, allowing the square to be partially visible only from its three corner intersections. In contrast, the isovist analysis of Piazza Michelangelo shows a much broader visual field from the surrounding streets. The square is clearly visible from most

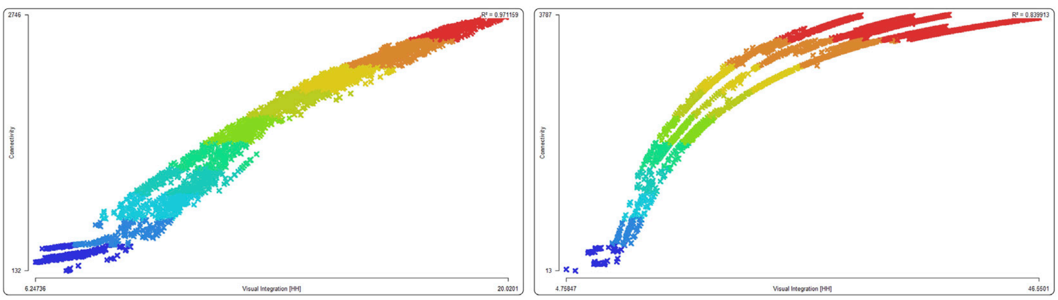

FIGURE 12
Correlation between visual integration and visual connectivity in the two case study squares.

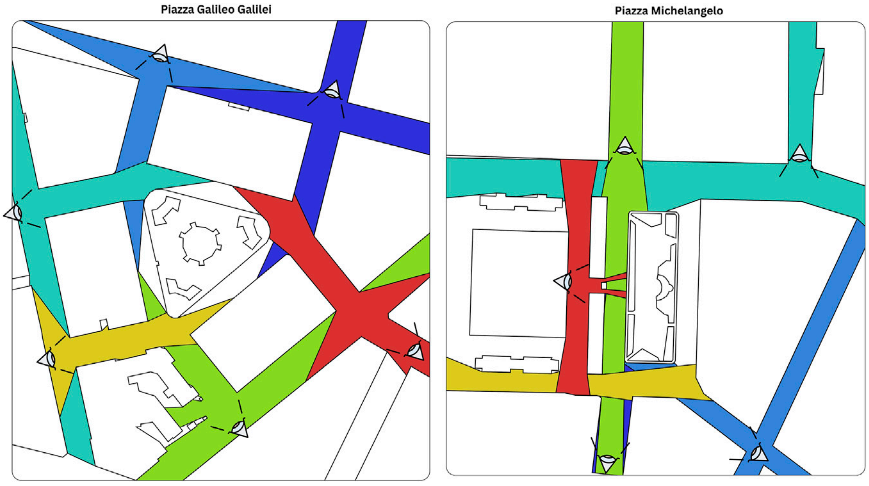

FIGURE 13
Isovist analysis of Piazza Galileo Galilei and Piazza Michelangelo showing visibility fields from surrounding streets.

of the main adjacent streets, with only one side exhibiting limited visibility due to building obstructions. This difference in visual permeability and exposure indicates that Piazza Michelangelo maintains stronger visual connections with its surrounding urban fabric, whereas Piazza Galileo Galilei remains visually concealed from much of the nearby street network, which may represent one of the spatial factors associated with the comparatively lower pedestrian presence observed in Piazza Galileo Galilei.

5 Discussion

The findings suggest that spatial visibility and configurational attributes constitute important components of the broader set of physical and functional characteristics influencing pedestrian activity within neighbourhood public squares. Although the comparative analyses consistently demonstrate associations between visibility measures and pedestrian density, the results also indicate that pedestrian use reflects the combined influence of spatial geometry, surrounding land-use intensity, active commercial frontages, seating opportunities, and the overall organisation of public-space amenities. Consequently, the observed differences between Piazza Galileo Galilei and Piazza Michelangelo should be interpreted as the outcome of multiple interacting urban characteristics rather than the effect of visibility alone. In particular, the results indicate that squares with stronger visual permeability to surrounding streets, higher levels of visual integration and connectivity, and clearer internal visibility structures tend to attract greater pedestrian presence and support a wider range of pedestrian activities. However, rather than demonstrating a direct causal relationship, the findings primarily reveal consistent correlations between configurational visibility conditions and observed pedestrian behaviour patterns.

Figure 14 synthesises the main findings derived from pedestrian observations, VGA, connectivity–integration correlation, and isovist analysis. The comparison highlights differences in average pedestrian presence, dominant movement zones, internal visibility structure, the relationship between connectivity and integration, and the visibility of each square from surrounding streets, illustrating how variations in spatial configuration and visual accessibility correspond with different levels of pedestrian activity in the two public spaces.

A comparison between the two case studies further demonstrates that these differences are reflected not only in the quantity of pedestrian presence but also in the nature of activities occurring within the spaces. Piazza Michelangelo consistently showed substantially higher levels of both passing and lingering activities throughout all observation periods. Passing activities were concentrated along the central movement corridor, while lingering activities occurred in visually open and accessible areas of the square, indicating that the space functions both as a pedestrian route and as a social environment encouraging temporary occupation and interaction. In contrast, Piazza Galileo Galilei showed lower levels of pedestrian activity overall, with movement patterns concentrated mainly along the perimeter edges and fewer users engaging in lingering behaviour. The impermeable visibility structure and weaker internal visual continuity of the square appear to limit the use of its central areas and reduce opportunities for prolonged occupation and social interaction.

These behavioural differences can also be interpreted in relation to the surrounding land-use structure of the two squares. Piazza Michelangelo is bordered by a more continuous concentration of commercial activities, cafés, restaurants, and public-oriented functions, which generate continuous pedestrian flows and contribute to higher levels of spatial activation. Combined with its stronger visual exposure and more integrated spatial configuration, these land uses appear to reinforce both pedestrian movement and social occupation of the square. Conversely, although Piazza Galileo Galilei also contains mixed surrounding functions, its weaker visual permeability and more fragmented configurational structure reduce the spatial legibility and visibility of the square from surrounding streets. The findings therefore suggest that the vitality of public spaces cannot be explained solely through the provision of physical amenities or surrounding

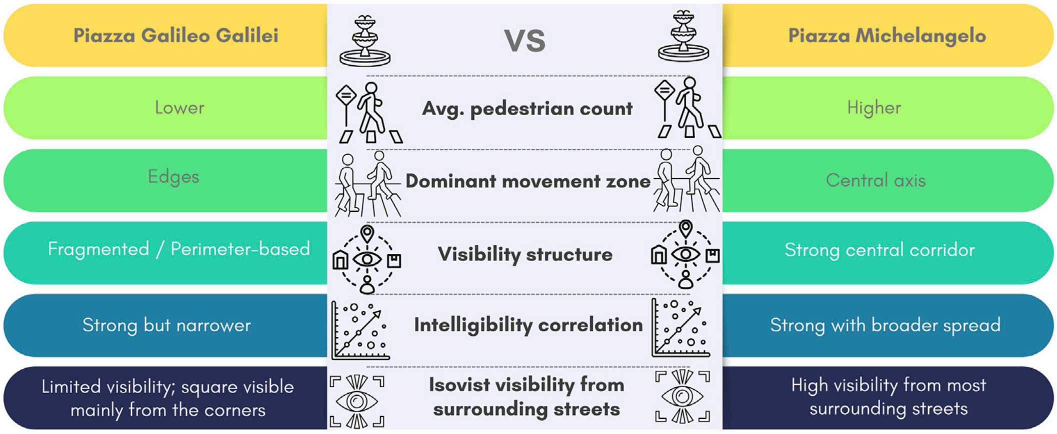

FIGURE 14
Comparative summary of key spatial and observational indicators between Piazza Galileo Galilei and Piazza Michelangelo.

functions, but is also closely associated with how spatial configuration and visibility conditions shape pedestrian perception, accessibility, movement, and opportunities for social interaction within the urban environment.

Beyond the higher pedestrian density observed in Piazza Michelangelo, the spatial distribution of lingering activities provides further insight into how public spaces are used. Field observations indicate that stationary activities were predominantly concentrated in areas combining high visual accessibility with supportive environmental conditions, including seating, and active commercial frontages. In Piazza Michelangelo, lingering frequently occurred along the central pedestrian corridor and adjacent seating areas, where high VGA values coincided with cafés, retail uses, and unobstructed visual connections to surrounding streets. Conversely, lingering activity in Piazza Galileo Galilei was comparatively limited and largely confined to peripheral seating areas beneath tree cover, despite the availability of similar physical amenities. The lower pedestrian density, fragmented visibility structure, weaker visual exposure from surrounding streets, and less active urban edges appear to reduce opportunities for prolonged occupation and spontaneous social interaction. These observations suggest that lingering behaviour is associated not with a single environmental characteristic but with the combined influence of spatial configuration, visual accessibility, active ground-floor uses, and supporting public-space amenities.

An additional contribution of this study emerges from comparing local-scale axial integration with the detailed visibility analyses conducted within the public squares. Although Piazza Galileo Galilei exhibits a slightly higher Integration (HH) R2 value within the surrounding street network than Piazza Michelangelo, it consistently demonstrates substantially lower pedestrian density, lower levels of lingering activity, and weaker overall public-space performance. This finding suggests that integration (HH) R2, although important for understanding local accessibility, is not sufficient by itself to explain the intensity of public-space use. Rather, the evidence indicates that pedestrian activity results from the interaction between multiple spatial factors operating at different scales. While axial integration describes the accessibility of the surrounding urban network, the VGA captures the internal visual organisation of the square, and the isovist analysis reflects how visible the public space is from approaching streets. Together with land-use intensity, active commercial frontages, and seating opportunities, these complementary factors provide a more comprehensive explanation of why Piazza Michelangelo attracts greater pedestrian activity despite exhibiting a slightly lower level of local street integration.

When compared to other studies in the field, the findings of this study align with and extend previous research investigating the relationship between spatial visibility, urban configuration, and human behavior in public spaces (Khotbehsara et al., 2022; Saeidi et al., 2024; Mohammed and Elhefnawy, 2025), while also presenting several methodological and contextual distinctions. Similar to prior studies (Mohammed, 2024; Askarizad and Garau, 2025), this research combines VGA with empirical observation to examine how spatial visibility relates to human activity. However, while their study focuses on validating visual attributes and agent-based simulation models, the present research concentrates on direct observational evidence on the intersection of pedestrian presence and visual permeability, providing a comparative analysis between two urban squares with different spatial visibility conditions. The role of visual accessibility and sightlines identified here is also consistent with the work of González-Gómez and Castro (2019), who analysed pedestrian visibility using 3D modelling data; nevertheless, their research primarily focuses on street intersections and vulnerable road users, whereas this study investigates visual permeability within public squares and their relationship to pedestrian use patterns. In contrast to the broader conceptual discussion of visibility and digital exposure in public spaces presented by Hatuka and Toch (2017), the present study examines physical spatial visibility and its impact on pedestrian mobility in urban environments.

Similarly, while Kamalipour and Peimani (2019) highlight the role of edges and public–private interfaces in structuring activities such as street trading, the current research focuses more specifically on how spatial configuration and visual accessibility influence pedestrian presence in open public squares. The findings also relate to the framework proposed by Fan et al. (2022), which integrates accessibility, visibility, and intelligibility for evaluating pedestrian-friendly green-blue spaces; however, their analysis operates at a citywide planning scale, whereas the present study investigates micro-scale spatial visibility conditions within individual urban squares. In addition, the methodological approach resonates with Garau et al. (2025), who combined space syntax techniques with qualitative urban analysis to identify underused residual spaces in the historic neighbourhoods. Another study by Sak-Acur and Sailer (2026) shows that spatial visibility strongly structures children's playground use, concentrating activity in highly visible central areas and producing unequal access across age and gender groups. This is aligned with the findings of this study, where higher visual accessibility and permeability correspond to greater pedestrian presence in urban squares, while fragmented visibility is associated with reduced use. However, the current study extends this logic to the urban scale, demonstrating that similar visibility–use relationships also shape pedestrian movement patterns in neighborhood public spaces.

Nevertheless, while their research focuses on urban regeneration strategies for neglected spaces, the current study examines how differences in spatial visibility and configuration influence the everyday use of existing public squares. Finally, although Attard et al. (2023) address inequalities in urban space allocation through large-scale analyses of transport infrastructure, the present study explores human-scale spatial visibility and pedestrian behaviour within public spaces, offering a more localised perspective on how spatial configuration can affect urban vitality through visual permeability. Unlike previous studies that primarily focused on validating configurational indicators within individual public spaces, this research adopts a comparative perspective, demonstrating how multiple spatial and contextual factors collectively correspond with differences in pedestrian activity between neighbourhood squares offering similar physical amenities. Through this comparative perspective, the study contributes to the growing body of research that emphasises the importance of spatial visibility and configurational properties in shaping the use and perception of public urban spaces.

The findings of this study have several implications for urban design practice and planning policies aimed at improving the sociability and usability of public squares. The results demonstrate that the visual accessibility and spatial configuration of public spaces play a fundamental role in shaping pedestrian presence and patterns of use. Squares that maintain stronger visual connections with surrounding streets and higher levels of spatial integration and connectivity are more likely to attract pedestrian activity and support social interaction. The findings suggest that improving visibility, strengthening active frontages, and integrating complementary public amenities may contribute to enhancing pedestrian use, although these implications should be interpreted in relation to local urban context and require validation through additional comparative studies. Design strategies such as maintaining open visual corridors, reducing visual barriers created by buildings or vegetation, and strengthening the relationship between surrounding pedestrian routes and the interior of squares can enhance spatial visibility and improve the attractiveness of public spaces. Additionally, the results suggest that central visibility corridors and well-integrated circulation paths can help structure pedestrian movement and encourage more active use of public squares. From a policy perspective, incorporating visibility-based spatial analysis tools such as space syntax and VGA into the planning and evaluation process can support evidence-based decision-making and help identify spatial configurations that promote more accessible, legible, and socially active public environments.

Despite the insights provided by this study, several limitations should be acknowledged. First, the analysis focuses on two case study squares within a single Italian neighbourhood, which may limit the generalisability of the findings to other urban contexts with different spatial structures, social dynamics, or cultural conditions. Second, the empirical observation was conducted during specific time periods of the day, which may not fully capture variations in pedestrian activity across different days of the week, tourist hub seasons, or special events. Additionally, the study primarily examines spatial visibility and configurational properties as factors influencing pedestrian presence, while other variables, such as microclimatic conditions, land-use patterns, commercial activities, and social or cultural factors are excluded within the scope of this study. Yet another limitation concerns the temporal scope of the empirical observations. Pedestrian observations were conducted during three representative periods of the day on comparable weekdays, providing snapshots of public-space use rather than continuous measurements across multiple days or seasons. Consequently, the findings should be interpreted as illustrating correlations between spatial characteristics and observed pedestrian activity under the recorded conditions rather than capturing the full temporal variability of public-space use. Future studies could strengthen these findings through repeated observations across weekdays, weekends, different seasons, and varying weather conditions.

Future research could therefore expand the scope by including a larger number of case studies across different urban environments, conducting longer-term observational studies, and integrating additional spatial and socio-environmental variables. Furthermore, combining advanced simulation methods, agent-based modelling, or pedestrian tracking technologies with configurational analysis could provide deeper insights into the dynamic relationship between spatial visibility, movement patterns, and public space vitality.

6 Conclusion

This study examined the relationship between spatial visibility, configurational properties, land-use structure, and pedestrian activity in urban public squares through a comparative analysis of Piazza Galileo Galilei and Piazza Michelangelo in the San Benedetto district of Cagliari. By integrating empirical pedestrian observations, activity mapping, VGA, correlation analysis, isovist analysis, and surrounding land-use assessment, the research developed a multi-layered analytical framework for investigating how spatial configuration and visual accessibility relate to the use and performance of public spaces. The findings reveal that differences in spatial integration, visibility structure, and external visual permeability correspond closely with variations in pedestrian presence, movement patterns, and lingering activities, even where the two squares provide relatively similar physical facilities such as seating areas, greenery, and pedestrian accessibility. In particular, Piazza Michelangelo, characterized by stronger visual exposure, clearer internal visibility structure, and a more active surrounding commercial environment, demonstrated substantially higher levels of both pedestrian movement and lingering activity compared to Piazza Galileo Galilei, where fragmented visibility and weaker spatial integration were associated with lower levels of spatial occupation.

These findings directly address the research questions by demonstrating that spatial configuration and visual permeability are strongly associated with pedestrian movement patterns and the overall vitality of neighborhood squares. The study further shows how space syntax–based analyses, particularly VGA and isovist analysis, can help explain why some public spaces attract greater pedestrian activity while others remain relatively underused despite offering comparable urban amenities. However, the research does not claim a deterministic causal relationship between spatial configuration and public-space use. Rather, the results identify consistent correlations between configurational visibility conditions, surrounding land-use structure, and observed pedestrian behaviour, suggesting that visibility and spatial accessibility operate as important spatial factors influencing how people perceive, access, move through, and temporarily occupy urban public spaces.

The originality of this study lies not in the application of VGA itself, but in integrating configurational analysis, isovist visibility assessment, surrounding land-use analysis, and empirical behavioural observations within a comparative framework to explain contrasting pedestrian performance between neighbourhood public squares with similar physical characteristics. Beyond its empirical findings, this study contributes to understanding how spatial configuration interacts with land-use characteristics, urban morphology, and environmental amenities in shaping the use of neighbourhood public spaces. Although the conclusions are derived from two case studies and should therefore be interpreted with appropriate caution, the proposed analytical framework offers a transferable approach for evaluating public-space performance in comparable urban contexts. Future studies involving larger samples of public spaces across different urban settings would further strengthen the generalisability of these findings and support the development of evidence-based urban design and planning strategies. In terms of planning practice, the study suggests that improving visual accessibility, strengthening spatial continuity with surrounding streets, and encouraging active edge functions may support the creation of more active, accessible, and socially responsive public spaces. Consequently, the proposed analytical framework offers a transferable approach for evaluating and designing neighborhood public spaces in other urban contexts, particularly in dense Mediterranean and mixed-use urban environments where pedestrian vitality and social interaction are central concerns of contemporary urban planning.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

MD: Conceptualization, Formal Analysis, Data curation, Investigation, Methodology, Software, Visualization, Writing – original draft. RA: Conceptualization, Formal Analysis, Data curation, Investigation, Methodology, Resources, Validation, Writing – review and editing. CG: Data curation, Investigation, Methodology, Project administration, Funding acquisition, Supervision, Validation, Writing – review and editing.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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