THE IMPACT OF SPATIAL CONFIGURATION ON HUMAN BEHAVIOR IN URBAN VOIDS: A CASE STUDY ON KALMUNAI TOWN

MEHNAS Y.[1]* & GAMAGE W O.[2]
[1, 2] Department of Architecture, University of Moratuwa, Sri Lanka
[1]*mehnasyunaitheen98@gmail.com*, [2]*wajishanig@uom.lk*

Abstract: This research explores the impact of spatial configuration in urban voids on user perception and behavior. Using Space Syntax Theory and Oldenburg's Third Place Theory, the study investigates how spatial configuration influences the use of urban spaces and the formation of social networks. The methodology consists of two parts: spatial analysis using DepthmapX software and a commuter perception survey. . Findings reveal that key spatial elements such as integration, visibility, and spatial closeness significantly affect how urban voids are perceived and utilized. Notably, some areas remain underused due to poor spatial connectivity with nearby urban blocks. This suggests that the usability of public spaces in mid-sized cities like Kalmunai relies not only on their availability but also on their spatial integration. The study highlights the importance of designing urban voids to promote accessibility and social engagement. These insights offer valuable guidance for urban designers seeking to reactivate neglected areas, foster social interaction, and enhance the livability of cities like Kalmunai. By rethinking the role of spatial structure, urban voids can be transformed into vibrant, inclusive public places.

Keywords: *Urban voids, Spatial configuration, Space Syntax, Accessibility, Sense of belongingness*

1. Introduction

Urban voids refer to neglected or underutilized spaces within cities, often resulting from fragmented urban development or changes in land use and socio-economic conditions (Hollander et al., 2020). These spaces include undeveloped plots, open sections of parks, and gaps between existing structures. Despite their derelict state, urban voids present valuable opportunities to be reintegrated into the urban fabric, enhancing social interaction, green space provision, and open space availability in dense built environments (Krause & Stephan, 2021; Chen et al., 2023). There are different types of urban voids; physical voids are as empty lands or abandoned buildings which that often fall into disuse due to economic decline or neglect, posing challenges and opportunities for redevelopment that can stimulate neighborhood economic activities (Zhang et al., 2018). Temporal voids are spaces unused for certain periods, such as event parking lots, whose engagement throughout the year can strengthen community connectivity (Jiang & Huo, 2016). Functional voids are physically occupied spaces lacking active use or public engagement, like empty squares or non-functioning recreational areas, often due to poor design or inadequate amenities (Gehl, 2010).Social voids are areas with limited social interaction caused by insecurity or weak community participation, highlighting the need for designs that foster belonging and safety (Al-Sayed et al., 2014).Environmental voids are spaces impaired by environmental issues such as noise, pollution, or unfavorable microclimates, which discourage outdoor use and necessitate improved landscaping and design interventions (Montello, 2007).

Urban voids pose challenges for community development and social cohesion. Barriers to their use include socio-economic constraints, lack of physical amenities, and planning policies which favour new construction over revitalization (Gehl, 2010; Carmona et al., 2010; Friedman, 2014). Without active community involvement and policy support, urban voids remain neglected, reducing their potential as social and environmental assets (Oldenburg, 1999). Historically neglected due to economic downturns or land use changes, urban voids are now increasingly viewed as opportunities to enhance urban experience. Strategies such as tactical urbanism, temporary installations, community gardens, and events activate these spaces and foster community pride (Bertolini, 2016; Sitte, 2009; Gonzalez, 2017; Lydon & Garcia, 2015). However, challenges like land ownership, regulatory constraints, and sustained community engagement remain critical for successful transformation (Hester, 2006).

The usage of urban voids depends largely on design quality, accessibility, and social context. Well-equipped voids with seating, landscaping, and lighting attract more users, supporting activities that promote community integration (Carmona et al., 2010; Oldenburg, 1999). Moreover, these spaces can complement grey infrastructure with green solutions like rain gardens or edible landscapes, enhancing urban sustainability (Bertolini, 2016). Effective management and local participation are essential to prevent underutilization and realize their full potential (Gonzalez, 2017; Friedman, 2014). Understanding spatial configuration, how routes, buildings, and open spaces are organized, helps explain why some urban areas remain underused and how they can be transformed into vibrant urban centres (Hillier & Hanson, 1984). Urban voids,

*Corresponding author: Tel: +94 770108711 Email Address: mehnasyunaitheen98@gmail.com
DOI: https://doi.org/10.31705/FARU.2025.79

although often seen as neglected or lifeless, hold potential to become active public spaces. Creative approaches such as community gardens, temporary structures, and tactical urbanism can transform these areas into vibrant, functional places that support social and cultural activities (McCarthy, 2016; Gehl, 2011).

2. Spatial Configuration and Its Impact on Human Behaviour

Spatial arrangement influences human behaviour through factors such as visibility, proximity, and integration. Visibility enhances ease of navigation and perception, thereby improving safety and attractiveness (Marcus & Legeby, 2019). Proximity and connectivity relate to how well spaces connect within the urban fabric, encouraging movement and social interaction (Sung et al., 2022; Yamu, van Nes & Garau, 2021). Integrated spaces with higher accessibility generate more pedestrian flow, which in turn supports social and economic activities (Hillier, 1996; Hillier et al., 1987). Public spaces that are open, visible, and well-connected foster socialization, while isolated spaces tend to become underutilized (Gehl, 2011). Spaces with unobstructed views, good connectivity, and active surroundings are perceived as safer due to increased passive surveillance, thus discouraging crime (Jacobs et al., 1961; Newman, 1972).

Safety, in terms of perception and reality, is given utmost importance in the context of public space use-as people avert themselves against unsafe areas and their limitation to comprise diverse users (Jacobs, 1961; Newman, 1972). Physical attributes such as good lighting, clear sightlines, active frontages, and continual presence of people increases the feeling of safety due to natural surveillance (Cozens & Love, 2015; Foster et al.,2010). Fear and avoidance from a place, on the contrary, set in with poorly visible spaces, barely accessible locations, and completely abandoned maintenance (Pain, 2000). The accessibility of an area can be broadly defined as how much persons can enter it and negotiate with respect to urban settings (Handy & Niemeier, 1997).

From a space syntax theory perspective, spatial integration supports accessibility by means of providing high movement flow and increasing capacity for chance social encounters (Hillier, 1996; Van Nes & Yamu, 2021).

The so-called place attachment; the emotional bond that grows between people and their environment-has been considered to have an important role in sustaining life in public spaces (Lewicka, 2011). Physical features such as seating, greenery, human-scale design, and symbolic or cultural considerations tend to reinforce the feeling of attachment for the user and encourage repeated visits (Relph, 1976; Scannell & Gifford, 2010). Low and Altman (1992) and Brown, Perkins & Brown (2003) note that spaces which develop attachment usually have an amalgam of comfort, identity, and socializing and these spaces create an atmosphere to facilitate longevity in engagement. The interaction among safety, accessibility, and attachment is crucial because unsafe and inaccessible spaces invite no one for its use, and attachment keeps such places used by people, effectively infusing the city with life.

3. Theoretical Frameworks on Activation of Urban Public Spaces and Voids

Urban theories offer valuable insight into how public spaces and urban voids can be designed and activated to support human behavior, social engagement, and community well-being.

It is based on the principles of human-centred design, spatial configuration analysis, sociology, and environmental psychology, together with the modern-day approaches to place activation. All these theories together guide the analytical path of the research and the subsequent criteria for assessing the current situation and suggesting context-responsive interventions

Human behaviour constitutes the first theoretical domain. Gehl's (2010) human-centred principles of comfort, walkability, seating and micro-scale design were the elements of the latter theory that would lead to people's coziness and interaction among the users. The observation of Whyte (1980) also points out that the presence of sunlight, movable seats and the already mentioned food vendors or similar activities are attractions that dictate how people would use small urban spaces. These theories are the basis for considering openness to emotions and good user experiences as the main criteria when looking for ways to convert voids into lively public spaces. The next point of view deals with the arrangement of space. Space Syntax Theory, created by Hillier and Hanson (1984), gives tools such as integration values and axial analysis for the explanation of how the layout affects the degree of movement, visibility and closeness to others. Lynch's (1960) idea of urban legibility is a further delineation of the influence of the previously mentioned elements—paths, nodes, edges, and landmarks—on people's cognitive and emotional relationships with place. Theoretical explanations of spatiality will direct the study in terms of connectivity, clarity and coherence of the spaces within the site.

The third component of the framework is sociability. Jacobs (1961) and Sennett (1977) accentuate public space as the main channel through which daily social interactions, variety, and the exercising of civic rights happen. Oldenburg's (1989) theory about "third places" provides a more comprehensive view of public spaces by placing informal, neutral, and accessible gathering sites that help develop community and social ties at the center of his argument. These viewpoints together point out the direction of the study to change voids into spaces that are socially meaningful and inclusive. Another theoretical line

is safety and perception. The principles of Newman's (1972) Defensible Space Theory articulate territoriality, natural surveillance, and clear spatial boundaries as the main factors that not only prevent but also make people feel safer. Alongside this, the CPTED model (Cozens & Love, 2015) points to visibility, lighting, maintenance, and accessibility as foundational aspects of creating safe and continuously populated public areas. These theories not only help to identify safety-related constraints but also serve to instruct the formulation of spatial strategies that enhance both actual and perceived security.

Besides classical theories, contemporary methods also shed light on current practices of place activation. Tactical urbanism, as described by Lydon and Garcia (2015), reveals that cheap, short-term, and community-driven interventions can explore and even promote the use of neglected areas. Current placemaking literature (Project for Public Spaces, 2018; Mehta, 2019) points out community participation, cultural programming, and co-creation as the main factors behind public places' success. Studies about temporary urban transformations (Bishop & Williams, 2012) give more proof that, through interim usages, walls or less frequented spaces can get their old life back and even public get involved right away. These modern views increase the framework's connection to the urban design practice of today. Contemporary Theory thus, forms an integration of theories that is both academically founded and able to analyze and activate urban public spaces and voids. The integration of these theories also facilitates the application of a specific research methodology, which includes measures of user behavior interpretation, evaluation of spatial structures, the support of social interactions, the assurance of safety, and the development of flexible activation strategies. The implications of these theories together with their integration consequently make the study backed by a strong conceptual foundation that is capable of producing significant and contextually suitable design interventions.

4. Methodology

Case study was selected based on spatial parameters and functional aspects grounded on characteristics that define urban voids. multifunctional hubs, are identified as essential features based on prior studies. multifunctional urban spaces offer opportunities for diverse activities, contributing to the social and economic vitality of urban environments (Gospodini, 2001). Kalmunai has a unique geographical, cultural, and urbanization characteristics. It is a mid-sized town situated in the Eastern Province of Sri Lanka. It functions as a significant regional hub, making it a relevant setting to explore urban voids and their relationship to the city fabric. When considering its urbanization patterns, although the town has experienced significant growth in recent times much of its urban space remains underutilized. Kalmunai's urban growth has led to the creation of certain mixed-use spaces, while other areas remain spatially isolated and underdeveloped, resulting in creation of several urban voids within the town. This offers an opportunity to uncover the impact of urban void spaces on human perception and their spatial characteristic which result in underutilization or successful activation of these spaces. Three urban void spaces within Kalmunai were randomly selected, and a buffer radius of 130 meters was applied around each site to define the study area. Spatial data were extracted from local street and building layers to develop axial and segment maps.

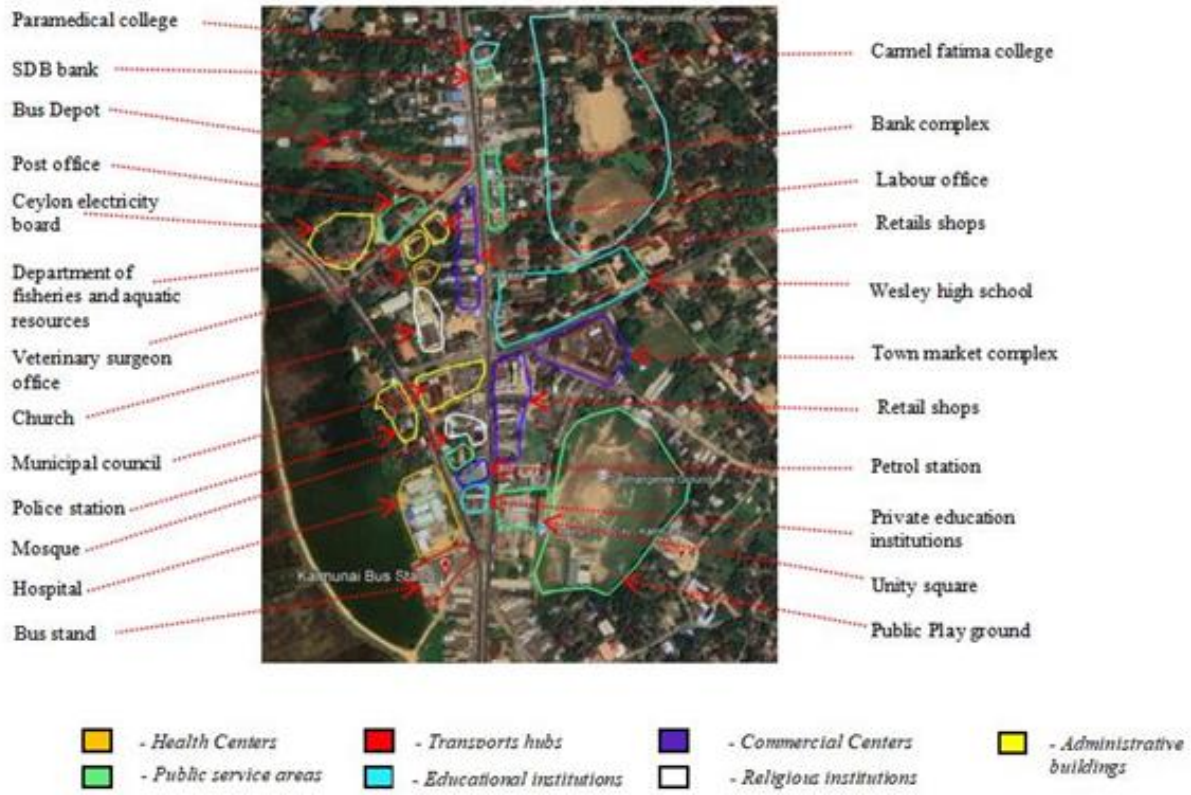

Figure 1: Infrastructure arrangement and diversity of Kalmunai town

Figure 2 shows the location and layout plans of selected urban voids within the Kalmunai town. The selected spaces are referred to as A, B and C. Space A lies in a somewhat modern quarter in between Wesley high school junction and the market. Its development dated back to the spatial urbanism of the mid-20th century. The area depicted is somewhat influenced by a grid like pattern but some organic elements remain islanded within. In this space the social composition is not homogeneous, both old and young people can be observed. Space B is primarily the newly developed areas; its layout entails more geometrical patterns and is more orderly with the roads being wider and clean separating the pedestrian and vehicular traffic. The area comprises mainly young families and working individuals social zoning includes planned social events; appropriate to the level of these networks of interaction. Space C is in the historical quarter of Kalmunai town, which comprises a more complex and less regular fabric like in the case of older cities. The socially active population in this area includes married residents with children as well as elderly people who have been living here for decades. Here the spatial organization is more simplified, which is, commensurate to narrow linear walkways, and the temporal activities indicate more community-oriented engagement with sociability featuring small informal gatherings rather than any cohesive format.

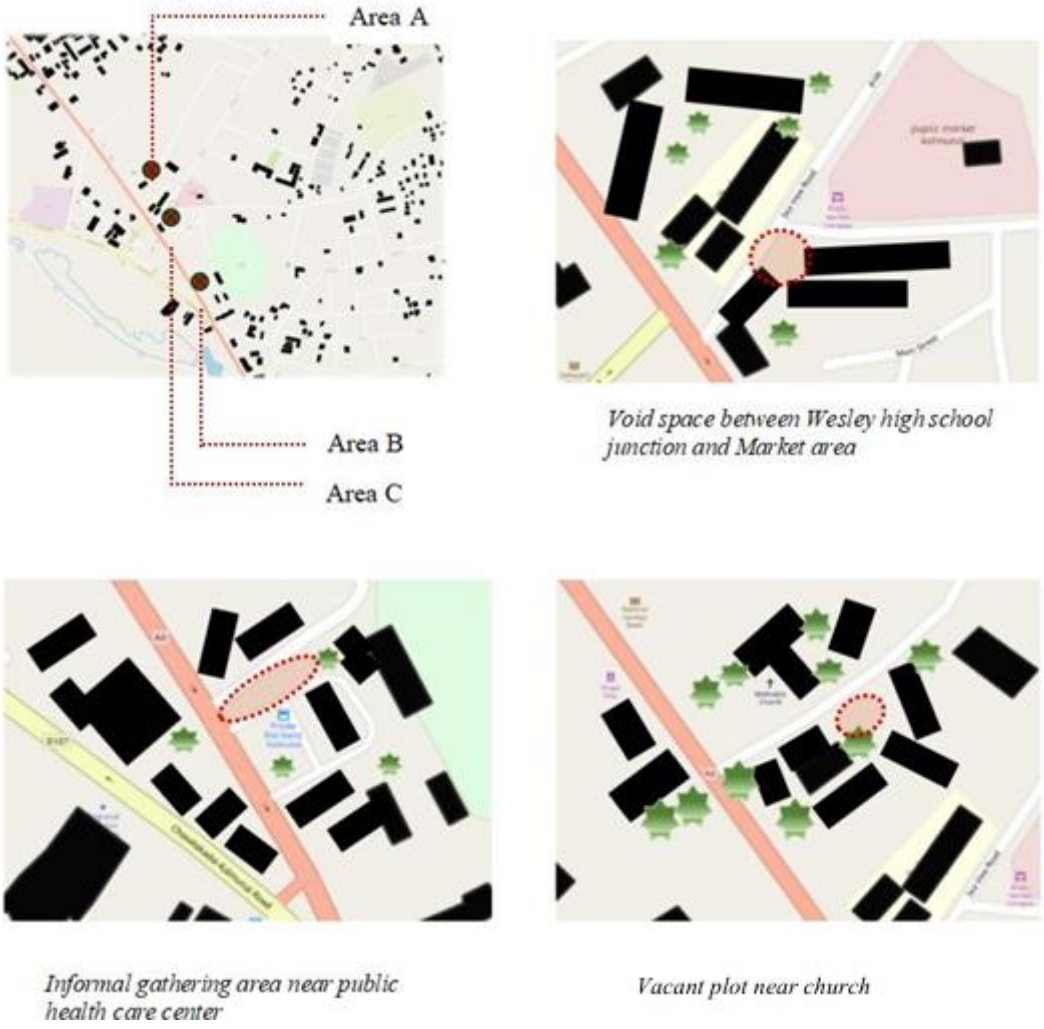

Figure 2: Location and arrangement of selected urban void spaces

The research methodology is divided to two stages to analyze the relationship between spatial configuration and commuter perception within the selected urban voids in Kalmunai, Sri Lanka.

1. Spatial Configuration Analysis: Space syntax analysis was conducted using DepthmapX software. Metrics such as Connectivity, Integration, and Visibility were evaluated through Axial Maps and Visibility Graph Analysis (VGA) to understand how spatial structure influences movement and interaction. DepthmapX is an open source and multi-platform spatial analysis software used to perform a set of spatial network analyses designed to understand social processes within the built environment. It works at a variety of scales from building through small urban to whole cities or states.

2. Commuter Perception Survey: A questionnaire was designed to assess three key variables: Sense of Safety (SOS), Ease of Access (EOA), and Sense of Belonging (SOB). Each variable included 7–8 indicator-based questions (Table 1). The instrument was validated by two experts in urban planning and architecture. A total of 45 surveys (15 per site) were

distributed using random samples, resulting in 31 completed responses (80% response rate). The target population included regular users and passersby of the selected void spaces.

Table 1: Variables measured in the questionnaire

Variable	Question	Scale Point	
		1	7
Sense of belonging (SOB)	Use of space for commuting	Strongly agree	Strongly disagree
	Use of space for socializing	Strongly agree	Strongly disagree
	Use of space for relaxation	Strongly agree	Strongly disagree
	Use of space for exercising	Strongly agree	Strongly disagree
	Use of space for business	Strongly agree	Strongly disagree
Sense of safety (SOS)	Amount of light	Very safe	Very unsafe
	Presences of security personal	Very safe	Very unsafe
	enclosure	Very safe	Very unsafe
	Safety in presences of others	Very safe	Very unsafe
	Overall safety	Very safe	Very unsafe
	Observation of unsafe incidents	Very often	Never
	Experience of unsafe incidents	Very often	Never
Ease of Access (EOA)	Access form surrounding area	Very Easy	Very Difficult
	Connection to surrounding area	Very well connected	Very poorly connected
	Physical design impact on ease of access	Strongly agree	Strongly disagree
	physical barriers on ease of access	Strongly agree	Strongly disagree
	Convenient to access through public transportation	Strongly agree	Strongly disagree
	Physical condition of access pathways good	Strongly agree	Strongly disagree

5. Results and Discussion

5.1 SPATIAL CONFIGURATION ANALYSIS OF THREE SELECTED URBAN VOIDS

The spatial configuration characteristic analysis of the three selected void spaces was conducted by the Visibility Graph Analysis (VGA) in depthmapX software with a cell size of 0.040 (Figure 2.). The visibility, connectivity, and integration values were calculated using the software (Table 2).

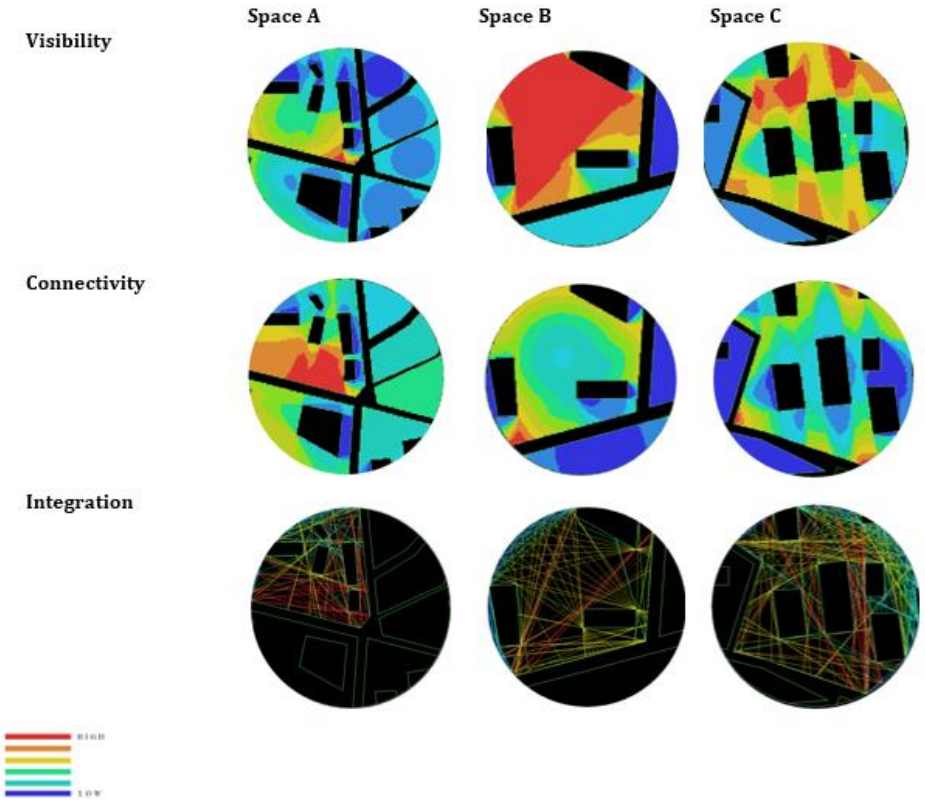

Figure 3: Visibility graph analysis of selected urban voids

Table 2: Statistics for variables measure form depthmap X software

	Visibility	Connectivity	Integration
Space A	0.483	6.342	0.892
Space B	0.498	5.893	0.583
Space C	0.346	3.987	0.352

Space A has the highest values for connectivity and integration. This indicates strong spatial links with the urban fabric around it. This is a result of space A being located in the densely populated central region of Kalmunai, adjacent to primary business and civic facilities, giving it high accessibility. The visibility statistic for this location can be considered moderate; hence, there are fairly clear visual links to neighboring areas that enable multi-purpose use and activity awareness from within and beyond the space. Space B offers comparatively higher visibility but moderate connectivity and integration scores. These values can be attributed to its location outside the urban core, within a fairly rigid street grid that provides sub-organization but lesser direct links into the dominant road network of the city. Hence, a somewhat semi-enclosed feel is created whereby activities are inclined to be more planned and controlled rather than spontaneous. The visibility therein is uneven; some parts are quite open to views, while others are partly blocked by residential alleys, a situation that goes on to generate a semi-private ambiance that impinges upon social interaction. Space C has comparatively lower values for all three measured parameters. This indicates fewer links with the wider urban network. Being situated in an estate newly developed on a low-density layout, it has an intercepted street pattern with poor access to main roads.

5.2 ANALYSIS OF COMMUTER PERCEPTION IN THREE SELECTED URBAN VOIDS

Commuter perception of three key variables sense of belonginess (SOB), sense of safety (SOS) and ease of access (EOA) was measured using the questionnaire survey. Proximity analysis presented in Figure 4, Indicates a striking variation in type of commuters who accessed each urban void. Space A has the highest proportion of commuters who reside outside a one-kilometer radius indicating variability in the composition of user groups. This may be due to the types of activities, location and function of the space.

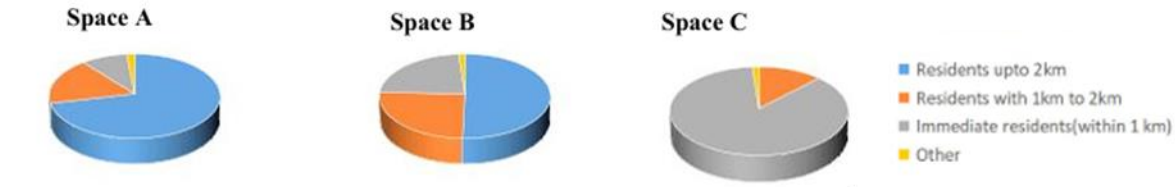

Figure 4: Proximity value for the urban voids

Table 3, summarize the questionnaire survey results of user perception related to SOB, SOS and EOA. The mean and standard deviation for each item measured on the Likert scale is shown here. Most responses in Space B and C have high standard deviation indicating significant differences in opinions related to tested parameters. Responses collected from Space A have lower standard deviations indicating that responses are clustered near the means. Most respondents in Space A utilized the space for socialization, relaxation and recreational purposes. Mean values for sense of safety in space A indicates that occupants felt higher confidence and safe with others who occupied the same space. This may be due to the type of users who gathered in Space A as a result of its high connectivity, integration and close proximity to many administrative areas in the central region of the town. Commuters also observed comparatively lesser unsafe incidents in the space. Although the spatial configuration analysis showed high level of connectivity and integration, higher perceived integration and connectivity is not observed through the questionnaire survey analysis. However, pedestrians perceived less physical barriers such as construction activity and traffic which strengthens ease of access to the space.

Table 3: Summary of questionnaire survey results

Variable	Question	Space A		Space B		Space C	
		Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Sense of belonging (SOB)	Use of space for commuting	3	.60	3.2	1.4	2.4	1.35
	Use of space for socializing	2	.70	3.5	1.27	3.2	1.4
	Use of space for relaxation	1	.46	3.4	1.26	2.5	1.78
	Use of space for exercising	2	.50	3.5	1.27	3.8	1.62
	Use of space for business	3	.78	2.6	1.51	3	1.33
Sense of safety (SOS)	Amount of light	4	.64	3.7	1.34	3	1.49
	Presences of security personal	3	.77	3.4	1.43	3.9	1.20
	enclosure	4	.70	3.1	1.20	2.7	1.34
	Safety in presences of others	2	.50	2.6	1.43	2.6	1.43
	Overall safety	3	1.04	2.2	1.14	3.3	1.16
	Observation of unsafe incidents	2	.80	3	1.49	3.5	1.58
	Experience of unsafe incidents	3	.70	2.8	1.23	3.4	1.26
	Access form surrounding area	4	0.66	3.2	1.4	3.6	1.35

Ease of Access (EOA)	Connection to surrounding area	5	0.46	1.8	1.32	3.8	1.55
	Physical design impact on ease of access	3	.80	3	1.25	2.8	1.40
	physical barriers on ease of access	4	.63	3.7	1.34	3.3	1.25
	Convenient to access through public transportation	5	.40	3	1.56	2.9	1.52
	Physical condition of access pathways good	4	.75	3.3	1.34	3.4	0.97

6. Conclusion

The analysis of the three urban voids reveals how differences in physical, environmental, and spatial characteristics impact their respective activation potential and overall performance as public spaces. Space A occupies the top position in performance because of its location at the very center, proper lighting, its shape that is partly closed off but has lively sides, its many openings, good flow of people to and from the surrounding streets and landmarks, and the presence of clean and well-kept amenities. All these factors together enhance the visibility, comfort, and social interaction, thus endorsing the human-centered design principles of Gehl (2010), the spatial integration insights of Hillier and Hanson (1984), and the sociability and third places arguments of Jacobs (1961) and Oldenburg (1989).

On the other hand, the limitations of Spaces B and C restrict their activation. Space B is connected to some extent but poorly illuminated at times, has narrow access routes and irregular floors that make the space less and less safe to be in. Space C, being the most inactive area, has an uninviting and unwelcoming atmosphere created by poor lighting, physical and visual disconnection, fragmented enclosure, and limited amenities. All these factors discourage the potential users and keep the place isolated and uninviting. These differences point out that the successful activation is not determined by a single factor but is made possible through the interrelationship of accessibility, spatial integration, visibility, maintenance, and social engagement The results pinpoint the most important features that must be present in urban voids in order to activate them. Lighting, permeability and visual connection are the features that improve both perceived and actual safety, hence the principles from CPTED (Cozens & Love, 2015) and Defensible Space theory (Newman, 1972) are reinforced. The edges of the places that are active, shaded seating, and clearly marked circulation paths are the factors that make social interaction take place and use prolonged, which is in agreement with Gehl's (2010) and Whyte's (1980) observations regarding human behavior. The spatial legibility- connectivity- and the surrounding urban network also determine the public activity's consistency, which is in line with the insights of Lynch (1960) and Space Syntax theory (Hillier & Hanson, 1984).

These findings can have a major impact on city design and politics. The different steps that can be taken to activate the empty spaces should first of all focus on better lighting, improving the places and ways people can get in and out of the spaces and making them easier to walk, and at the same time offering seats, trees for shade, and activities to lure people to hang around. The airing out of the spaces and exposing them to the public through temporary activation such as tactical urbanism and pop-up performances are some of the economical options that one can use to experiment with the space and create activity even in the areas with some structural limitations (Lydon & Garcia, 2015; Bishop & Williams, 2012; Project for Public Spaces, 2018). Day-to-day cleaning and caring, proper lighting, and indirect designs can be some of the ways to further change the areas that are not being used much into safe, inclusive, and lively urban settings. To sum up the story, the cross-comparison of A, B, and C spaces is an example showing the successful opening up of urban voids as depending on the combined influence of environmental, spatial, and social features. The interconnection of empirical observations with the established theories of human behaviour, spatial configuration, sociability, and safety makes the research provide a detailed understanding of public space performance. Besides, the results give planners and the like a practical strategy to convert the overlooked or undesirable urban areas into vibrant, well-connected, and inclusive public spaces that ultimately lead to the endorsement of sustainable and resilient urban development.

7. References

Carmona, M. (2010). *Public places, urban spaces: The dimensions of urban design.* Routledge.

Francis, J., Giles-Corti, B., & Wood, L. (2012). Creating socially inclusive public spaces: The role of spatial design in facilitating social interaction. *Journal of Urban Design*.

Gehl, J. (2011). *Life between buildings: Using public space.* Island Press.

Hillier, B., & Hanson, J. (1984). *The social logic of space.* Cambridge University Press.

Jacobs, J. (1961). *The death and life of great American cities.* Random House.

Kuo, F. E., & Sullivan, W. C. (2001). Environment and crime in the inner city: Does vegetation reduce crime? *Environment and Behavior*.

McCarthy, J. (2016). Urban voids and public space: Rethinking urban design in neglected areas. *Journal of Urbanism*.

Gehl, J., Svarre, B., & De Boer, J. (2016). *How to study public life.* Island Press. Lefebvre, H. (1991). *The production of space* (D. Nicholson-Smith, Trans.). Blackwell.

Oldenburg, R. (1991). *The great good place: Cafés, coffee shops, community centers, beauty parlors, general stores, bars, hangouts, and how they get you through the day.* Marlowe & Company.

Habraken, N. J. (1998). *Supporting the user's image of the environment*. The MIT Press.

Kearns, A., & Turok, I. (2003). What makes a 'city' a 'city'? *Urban Studies, 40*(12), 2353-2367.
Moughtin, C. (2003). *Urban design: Street and square*. Architectural Press. Thwaites, K., & Simkins, I. (2007). *Outdoor spaces: People's places*. Taylor &
Francis.
Lang, J. (2005). *Urban design: A typology of procedures and products*. Architectural Press.

Bentley, I., Alcock, A., & Greed, C. (1985). *Responsive environments: A manual for designers*. Architectural Press.
Hillier, B. (1996). *Space is the machine: A configurational theory of architecture*.
Space Syntax.
Whyte, W. H. (1980). *The social life of small urban spaces*. Project for Public Spaces.
Talen, E. (1999). Sense of community and neighborhood form: An assessment of the social doctrine of New Urbanism. *Urban Affairs Review, 35*(4), 526-556.
Elmhirst, S. (2008). The role of public space in the everyday lives of urban dwellers: An exploratory study of the role of place in social interaction. *Urban Studies, 45*(9), 1825-1843.
Carr, S., Francis, M., Rivlin, L. G., & Stone, A. M. (1992). *Public space*. Cambridge University Press.
Cresswell, T. (1996). *In place/out of place: Geography, ideology, and transgression*.
University of Minnesota Press.