SPACE SYNTAX SPATIAL ANALYSIS FOR PUBLIC HOUSINGS AND THE SENSE OF SAFETY

SUJATAVANI GUNASAGARAN[1,2,*], SIEW XU GAN[1],
TAMILSALVI MARI[1,2], SUCHARITA SRIRANGAM[1,2]

[1,2]School of Architecture Building, and Design, Taylor's University,
Taylor's Lakeside Campus,
No. 1 Jalan Taylor's, 47500, Subang Jaya, Selangor DE, Malaysia
[2]Liveable Urban Communities Impact Lab, Taylor's University, Taylor's Lakeside
*Corresponding Author: *Sujatavani.Gunasagaran@taylors.edu.my*

Abstract

This study utilised the space syntax approach to examine the design of the physical environment in public housing in Malaysia to reduce the likelihood of crime. Two case studies, namely the People's Housing Program (PPR) Kampung Baru Air Panas and Public Housing Sri Kelantan, were selected in Kuala Lumpur for qualitative analysis. Three analytical aspects, namely Isovist mapping, Visibility Graph Analysis, and convex mapping, were employed using the DepthmapX software to measure the probability of crime occurrence based on the layout of the selected cases. Thus, crime likelihood was assessed in three dimensions: permeability, visual accessibility, and physical accessibility. The research findings revealed the identification of break-in zones and the factors contributing to crime occurrence based on the research outcomes. Notably, both public housing developments demonstrated a strong relationship between spatial design aspects and the sense of safety, emphasising the significance of well-designed architectural spaces in ensuring security. The study's scope was limited to two public housing developments in Kuala Lumpur due to the primary focus on crime occurrence and time constraints. The employed methodology primarily served as a predictive tool; therefore, the findings may not entirely capture the complexity of reality. This study did not extensively explore other influential factors and considerations, such as pedestrian behaviour, site conditions, and demographic factors, which could also impact the probability of crime. In conclusion, the spatial network analyses conducted in this study contribute to our understanding of how space syntax can inform crime prevention in the built environment and the design of safe public housing. The findings underscore the significance of well-planned spatial layouts in public housing for promoting the safety and well-being of occupants. Future studies can further explore the application of spatial network analyses in architectural design to create secure living environments. Additionally, developing a safety index utilising space syntax could be a fruitful area of investigation in future research endeavours.

Keywords: Crime prevention; Public housing; Sense of safety; Space Syntax

1. Introduction

Criminal activity was defined as violence and anti-social behaviour, representing a significant societal problem in daily life. According to White's et al. [1] research, everyone experienced at least one criminal behaviour during their lifetime. In 2015, approximately 10 million individuals fell victim to crimes, with one in every ten incidents involving a youngster. Malaysia had a higher crime index (65.56) compared to Vietnam (53.45), Cambodia (52.72), and Indonesia (52.16) [2]. Malaysia's Crime Statistics [3] revealed that the most common criminal offences in 2019 and 2020 were categorised as follows: i) property crimes included vehicle theft, house break-ins, theft, snatch theft, and others, while ii) violent crimes comprised robbery, assault causing injury, rape, and murder.

The design planning of public housing in terms of property accessibility and security also affected the behaviour of burglars in terms of their opportunism and intentions to commit crimes [4, 5]. Factors such as accessibility, visibility, level of security, and living conditions of the victim's home influenced the considerations of burglars when committing a crime, potentially affecting their criminal decisions and choice of targets [6].

In Kuala Lumpur, public housing has emerged as a primary target for burglars and thieves due to the ease of accessing housing areas without surveillance or restrictions. Consequently, this situation has instilled fear and distress among public housing occupants. Although public housing was initially designed to provide quality and safe accommodations for the low-income group, it is no longer considered safe. According to a newspaper article by Marzuki [7], snatch theft, robbery, and break-ins have become prevalent in many public housing neighbourhoods, leading to anxiety among residents. Kuala Lumpur's public housing is now known as a crime-ridden area, even compared to other types of housing. Marzuki further exemplified how the physical environment, characterised by dense shrubs and poorly lit alternate routes that people seldom utilise, creates an ominous atmosphere that presents opportunities for burglaries.

Furthermore, it was discovered in some cases that the entrances to public housing were unrestricted, allowing easy access to residential areas. Additionally, Ali et al. [8] researched the safety level of affordable housing based on the safe city concept. They reported that the People's Housing Projects (PPR) Kampung Baru Air Panas scored the lowest (40%) and below 50% in crime indicators among 16 public housing developments in Kuala Lumpur. This indicates that this particular public housing area has experienced a high number of crimes in recent years.

1.1. Criteria of crime occurrence and architecture

Based on the routine activity theory, a successful crime requires three components: an offender, a target, and a favourable environment [9]. The spatial layout and design of the physical environment inevitably and significantly influence the probability of crime, making it essential to evaluate crime prevention strategies. For instance, Summer and Johnson [10] discussed the importance of layout design in crime reduction. Their study revealed that roadway segments with well-planned designs and good permeability had the lowest rates of outdoor crimes. Therefore, the accessibility, design, and layout of public housing significantly impact the likelihood of crime occurrence. The absence of control over factors such as

openness, permeability, visibility, and accessibility create an environment where criminals can freely navigate within public housing areas. As a result, the design considerations of the physical environment in public housing must prioritise the safety and well-being of occupants. Doing so ensures the maintenance of high quality of life for the residents.

1.2. The sense of safety and crime in public housing

The sense of safety is intricately linked to the quality of the community's living environment, where individuals experience a sense of security and freedom from fear or constraints caused by criminal activity or disorder. The Royal Malaysian Police's Index crime statistics [3] reported that the most common residential crimes included house break-ins, gang robberies, and vehicle thefts. These issues pertaining to residential crimes have garnered significant attention in recent years. Multiple studies have been undertaken to investigate this issue, leading to varying and inconclusive results. As reported in the Crime Statistics in Malaysia [3], Fig. 1, robberies comprised 55.2% of violent crimes, while vehicle thefts accounted for 41.2% of property crimes.

However, the conditions of the living environment can influence crime occurrence in public housing. Factors such as the physical spatial layout and surrounding views directly impact crime. Previous studies have indicated that segregated areas with low accessibility and integration contribute to higher crime rates [11, 12]. This suggests that an unfavourable physical environment design can increase the likelihood of crime in public housing areas [13]. The design of the built environment can play a role in deterring criminal behaviour.
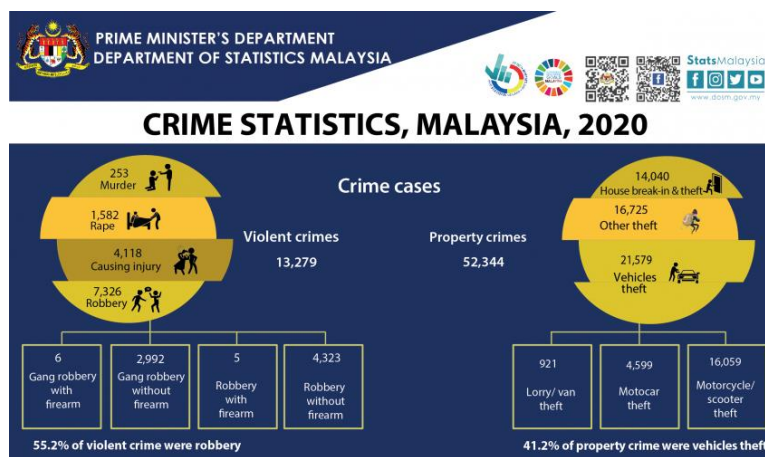

Fig. 1. Crime Statistics Malaysia in 2020 [3].

1.3. Space syntax as an analytical tool for the sense of safety.

Space syntax is a method that was used as a tool to help architects to simulate the likely effects of social projects and later has been developed as a design method which can determine the nature of space, and help to understand how buildings, areas, and even entire cities operate. Numerous studies have discussed using space syntax to measure the sense of safety [11, 12, 14-19]. The space syntax approach in this study focuses on spatial configurations and accessibility, analysing the

probability of crime in residential complexes. It offers a method to address the extensive urban spaces by forecasting the general layout of the selected area. This allowed for the prediction of crime-prone zones [16].

The literature review was conducted to establish the research framework and enhance the understanding of the current research. Numerous factors drawn from multiple sources were utilised to aid in developing data collection in Chapter 3. Table 1 summarises the aspects used to measure the sense of safety in public housing using space syntax theory. All the authors discussed spatial configurations, (in Table 1) followed by discussions on visibility and accessibility by six (6) authors and aspects of openness and permeability by one (1) author.

Table 1. Aspects that can influence crime prevention in housing areas.

Authors	Aspects of measuring the crime by space syntax in housing		
	Spatial Configurations	Openness & Permeability	Visibility & Accessibility
Awtuch [14]	✓		
Bendjedidi et al. [15]	✓	✓	✓
Heidari and Gastasebi [16]	✓		✓
Shu et al. [20]	✓		✓
Jones and Fanek [11]	✓		✓
Mahdzar et al. [18]	✓		✓
Othman et al. [19]	✓		✓

Additionally, the space syntax theory has provided valuable insights into environmental crime. Hiller and Shu [21] utilised syntactical approaches to investigate the impact of urban layout types on crime prevention in their book "Crime and Urban Layout." The study [17] also used space syntax theory to estimate the crime rates in London districts' different public and private areas. With software that facilitates the visualisation of the model in three dimensions, it has become feasible to conduct thorough and accurate analyses. Therefore, these methods were employed to analyse the cases in this study.

Several physical aspects play a role in determining the susceptibility of the living environment to crime. However, accessibility and visibility are the most crucial aspects when predicting crime in the physical environment. Factors such as the degree of connectivity and space integration also serve as effective indicators that influence the crime environment [16]. Consequently, the space syntax approach enables the identification of crime hotspots likely to occur within the living environment without requiring direct input from the occupants.

1.4. Approaches in measure of crime prevention by using Space Syntax

1.4.1. Spatial configurations

Spatial configuration refers to how the interaction between two spaces is influenced by a connection to a third space [18]. The organisation of the site and the arrangement of blocks can impact the physical environment, affecting human behaviour in terms of accommodation, facilitation, and constraint [22]. Examining

different typologies of spatial configurations in public housing allows for identifying various circumstances within the physical environment and their impact on the probability of crime. Hillier [23] played a pioneering role in contributing to space syntax theory, which encompassed tangible aspects such as movement and land use and intangible aspects such as cognition and behaviour. Therefore, calculating spatial configurations enables a more comprehensive and reliable analysis of preliminary statistical design.

A recent study by Yamu et al. [24] discussed the three elementary spatial units commonly utilised in space syntax theory: axial lines, convex spaces, and Isovist fields. Axial lines represent pathways for movement within specific areas of the built environment. Hillier and Hanson [25] defined axial lines as public spaces that connect to other public spaces. Alternatively, convex spaces are regions in which all points inside can be linked to one another without leaving the space. They are indivisible and often used to represent place-bound functions and activity zones. As described by Benedikt [26], an Isovist field represents a viewer's perspective from a specific location within the physical environment. It refers to what can be seen from that point within a 360-degree or 180-degree perspective. Figure 2 illustrates the three elementary spatial units used in space syntax.
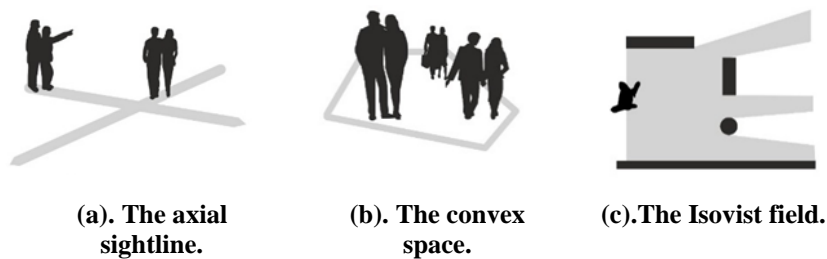

| (a). The axial sightline. | (b). The convex space. | (c).The Isovist field. |

Fig. 2. 3 elementary spatial units used in space syntax.

1.4.2. Openness and permeability

Openness and permeability are tangible factors that various authors have frequently cited influencing the crime rate in housing environments. Oscar Newman's defensible space theory 1973 emphasised the importance of defining space by classifying it into private, semi-private, semi-public, and public zones to enhance residents' surveillance within a housing environment [27]. Increased control and surveillance in semi-public and public spaces create a safer living environment, alleviating residents' concerns about crime.

However, issues arise when individuals disregard shared or public areas within housing blocks that belong to multiple households, leading to a lack of identification or a sense of belonging to a specific zone within the housing area [16]. Consequently, this can contribute to an unsafe physical environment. Tracing responsibility for the environment also becomes challenging, increasing the likelihood of criminality in public spaces [27]. In residential blocks, the public space is characterised by open and unrestricted access, while the plot is privately owned and often has limited visibility and accessibility [28]. Similarly, Lewis [29] argued that housing should differentiate between the front and back of buildings in terms of enclosure.

Ismail et al. [30] also highlighted the importance of interface areas that connect private and public zones. Effective zoning can protect inhabitants' privacy and create a separation between public and private spaces, preventing unauthorised access to the private section. This compartmentalisation of public and private spaces helps control the flow of people's movement. For instance, public spaces provide opportunities for social interactions and help avoid the presence of unused spaces that could be misused for illegal activities. Spaces such as closed or abandoned buildings, parking lots, and garages can create opportunities for criminals to access residential areas and conduct unlawful activities. Therefore, proper design and management of public spaces are essential in deterring criminal infiltration in residential areas.

1.4.3. Visibility and accessibility

Visual and physical access to residential blocks significantly contributes to crime in public housing. The level of spatial integration greatly influences physical accessibility. When there is more interconnected space, it becomes easier to access semi-private areas physically [25]. Physical access is also influenced by the degree of visibility towards the physical environment. Regardless of the distance between viewpoints, issues arise when there is insufficient visual awareness of the surroundings [31]. In simpler terms, greater transparency leads to a lower likelihood of crime occurrence. However, evaluating the ground area in the environment requires consideration of potential blind spots and obstructions to users' views [32, 33]. In other words, as the surroundings become more evident, the probability of crime decreases, offering fewer opportunities for criminals to enter the areas.

Additionally, in terms of visual access, the likelihood of criminals committing a crime is lower in settings where visual abilities are utilised to survey the areas [16]. This is because visual elements may be physically inaccessible to humans. Evaluating this solely based on the ground plan is challenging, as visual accessibility extends beyond physical reach [34]. Therefore, larger open areas that provide clearer lines of sight on the ground are associated with a lower probability of crime occurrence in the environment. According to Lis et al. [35], walking in a public space with higher visibility, improved accessibility, and no hiding spots is considered more desirable as it reduces the perceived danger and opportunities for crime. These findings suggest that the landscape should be designed to minimise hiding places, creating an environment where individuals feel protected and exposed. People naturally desire to observe their surroundings and be aware of what is happening in their environment.

By controlling visual permeability, ecological design elements, such as fences and tree height, can protect residents from unpleasant sensations and contribute to their sense of safety in public spaces [36, 37]. The perceptions of safety among occupants are closely related to their activities and the spatial attributes of legibility and permeability. The spatial configuration of public housing plays a significant role in shaping the impact of safety on occupants, encompassing both social aspects and the physical setting of housing. Table 2 shows the space syntax crime analysis prediction used in previous study and Table 3 shows the selected strategies and tactics for this study using the 2 chosen public housings as the case study.

**Table 2. Factors of crime investigation and
measurement in security creation by software indicators.**

Investigating factors	Description	Utility factor
Permeability	Increased connectivity and integration decreased opportunities for crime within an area. The mean depth measurement indicates a user's difficulty reaching their destination and is associated with an increased likelihood of crime. Furthermore, crime is more likely to occur when one side of the layout is farther away from the centre.	Axial map, integration analysis
Visual Accessibility	Visual access is evaluated in three dimensions, often referred to as "volume" or "cone vision" [16]. Criminals tend to avoid committing crimes in visually accessible settings. Therefore, when there is a larger gap between two areas easily identified and observed from a distance on the ground, the likelihood of crime occurring in that environment decreases.	Isovist Mapping
Physical Accessibility	The larger the surface area of a convex space with few obstacles for users, the lower the likelihood of crime occurring in that particular environment [32, 33]	VGA

2. Methodology

This research was conducted using a qualitative approach through two (2) case study in Kuala Lumpur to analyse the physical environmental design of public housings using the space syntax approach. The case study technique employed involves investigating a setting or phenomenon within its context [38].

The major advantage of using case study was the ability for researchers to understand in-depth the phenomenon of public housing within the specific site by observing the factors that influenced the sense of safety concerning the physical environment. The case study was significant due to its extensive range and various evidence sources. Through the literature review, the researchers generated the various aspects of the sense of safety in public housing, which guided the strategies and tactics employed to achieve the objectives of this research. The study was conducted through a critical space syntax analysis and on-site observation to reduce biases and validate the findings.

Table 3. Source of evidence to measure sense of safety.

Aspects of spatial design	Strategies	Tactics
Permeability	Space Syntax Method	Axial analysis
Visual Accessibility		Isovist Mapping
Physical Accessibility		Visibility Graph Analysis

The research was conducted in the district of Kuala Lumpur, which formed part of a broader population territory and was surrounded by dominant land uses

that supported a competitive economic structure. This research focused on the layout of public housing, namely Public Housing Sri Kelantan, Sentul, and PPR Kampung Baru Air Panas, Setapak (Fig. 3). These selected areas were experiencing significant development, with numerous new constructions contributing to population density and social concerns. Consequently, the expectation was that a rapidly developing neighbourhood would increase crime rates.
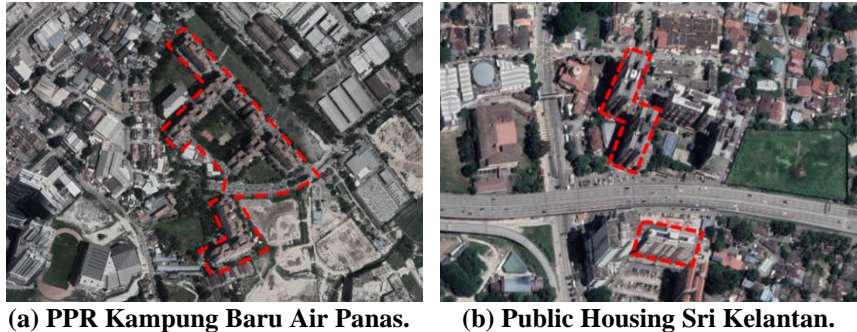

(a) PPR Kampung Baru Air Panas. **(b) Public Housing Sri Kelantan.**

Fig. 3. The study area is highlighted in red for the 2 PPR housing.

3. Results and Discussion

3.1. Space syntax application: Visibility graph analysis (VGA)

This analysis was conducted using the software DepthmapX. As mentioned earlier, DepthmapX is a visual analysis tool developed by Alasdair Turner, specifically utilised for syntactic analysis in the current study. It was employed to generate detailed measurements and diagrams for the investigation. The analysis was performed for both case studies to evaluate the existing layout from a syntactic perspective, allowing for visibility measurement.

The results indicated that highlighted red areas exhibited the highest visibility, while those marked with blue and green had the lowest visibility. Figure 4(a) illustrates the Visibility Graph Analysis (VGA) results for PPR Kampung Baru Air Panas. The main access road to the property (indicated by the darkest red zone) demonstrated the highest visual integration, with visually exposed, accessible, and well-integrated spaces leading to the main entrance. In contrast, the entrances to residential blocks G and H exhibited low visual integration due to their proximity to dead ends. Block B displayed the highest visual integration value, as its orientation faced an exposed space without any obstructions or blind spots surrounding it.

Moving on to the analysis of visual integration for public housing in Sri Kelantan, as shown in Figure 4(b), it was found to have lower values than PPR Kampung Baru Air Panas. The complex network circulation within the blocks resulted in multiple dead ends, leading to minimal visual integration. Among the blocks, Block B demonstrated greater visual integration. The open outdoor space contributed to moderate visibility, as it was fully exposed. However, the analysis revealed that Block A and Block C had the lowest visual integration values compared to Block B. This was due to the obstruction caused by surrounding blocks, leading to numerous blind spots for Block A, while Block C had only one main entrance beneath a flyover, resulting in limited accessible visual points.
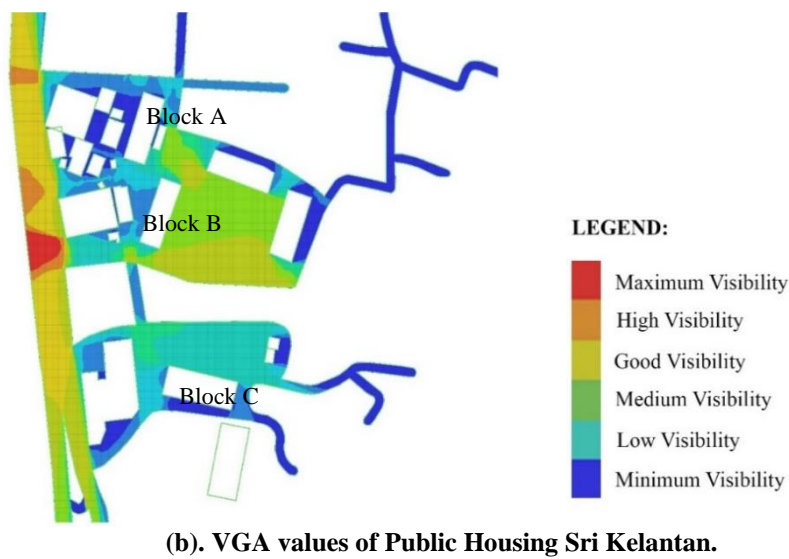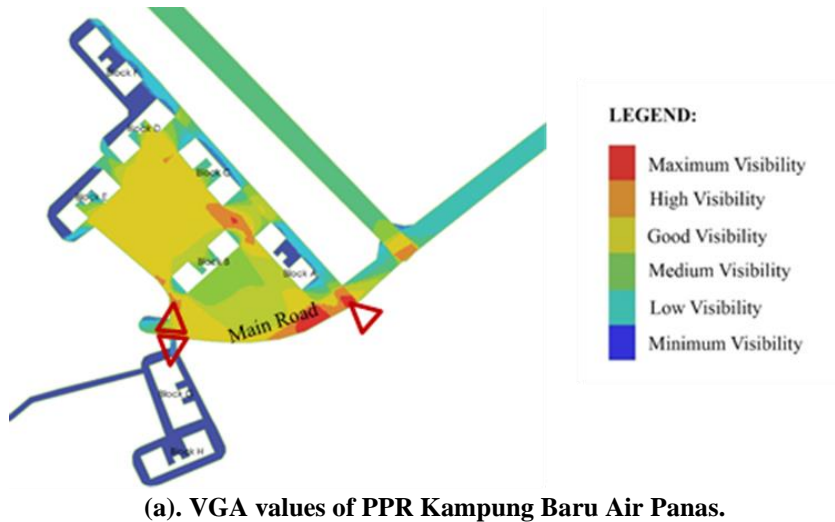
(a). VGA values of PPR Kampung Baru Air Panas.

(b). VGA values of Public Housing Sri Kelantan.

**Fig. 4. Results of the VGA for the visual
integration values of public housing.**

Based on the analysis depicted in both Figs. 4(a) and (b), it can be inferred from the graphs that block with lower visual integration values (dark blue) have a higher tendency for crime occurrence. Conversely, blocks with higher visibility values (red) at entry points indicate a lower possibility of crime. In other words, a low value of visual integration signifies a higher probability of crime, as blind spots may provide hiding places for criminals to conduct illicit activities. The presence of dead ends or blind spots within the site can contribute to crime occurrence. Therefore, it is imperative to enhance the security of these specific zones to deter crime in the physical environment of public housing.

Regarding the overall accessibility of the space, PPR Kampung Baru Air Panas exhibited better conditions than public housing in Sri Kelantan. This observation is likely attributed to block layout, regular arrangement, and the larger number of blocks. However, the complexity of space resulting from a lack of readability also indicates the prevalence of crime in both the physical environment and the spaces.

3.2. Space syntax application: Isovist mapping

The analysis of visible space from a specific location in the indicated point of view included performing single 2D Isovists mapping. In Figs. 4 and 5, the visual point locations were determined based on the main entry of public housing and the empty open space, which provided the maximum visibility to the residential blocks from that viewpoint. The analysis in Fig. 5 revealed that Blocks A and B in PPR Kampung Baru Air Panas had the highest visibility, being easily noticeable from the main road (indicated by the blue colour).

The inner open space within PPR Kampung Baru Air Panas also contributed to the visibility observed in the Isovists mapping. The mapping showed that Blocks A, B, C, D, and E had clear and unobstructed visual connections from the viewpoint of the open space. Thus, these blocks were highly visible from the open space. However, Blocks F, G, and H had hindered views compared to the other blocks. These blocks were organised to hide behind trees and obstructions, obstructing the line of sight from the generating point (open space). Consequently, the Isovists had very limited visibility of their surroundings.

In the isovists mapping of public housing in Sri Kelantan in Fig. 5, three points were indicated within the space. Block B appeared to have the highest visibility, as it occupied the largest visual field from the open space and the main road. The outdoor car park area in front of Block C also contributed to a significant visual field, with an unobstructed view of the block's frontage. However, Block A had the least visibility among all the blocks. The narrow access and obstructions, such as hawker stalls and surrounding trees, hindered the view, posing safety threats to the occupants.

3.3. Space syntax application: Integration analysis graph

The analysis of the convex map in public housing was conducted to derive the connectivity value based on the integration of the blocks. According to Hillier's space syntax theory [23], a higher connectivity and integration value indicates a lower likelihood of crime opportunity. Conversely, a greater depth between locations increases the probability of crime.

The PPR Kampung Baru Air Panas integration analysis revealed that Blocks C and D had the highest connectivity scores in Fig. 6. These blocks had a well-interconnected spatial layout design, with multiple connections to axial spaces, making them more accessible as destinations and pathways to other spaces. On the other hand, Blocks E, F, G, and H had the lowest integration values according to the analysis results. These blocks were located at the termination of the site, which restricted their connectivity with other blocks. It was also observed that passing through Blocks E, F, G, and H required a longer path from the entrance to reach the destination, whereas Blocks A and B were only accessible through the entry point. Consequently, Blocks E, F, G, and H's depth were greater than the other blocks.
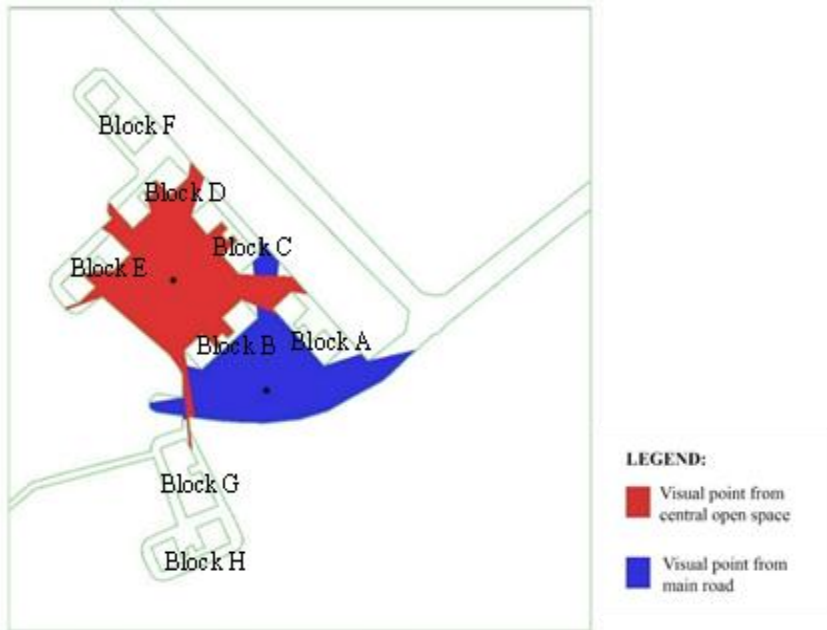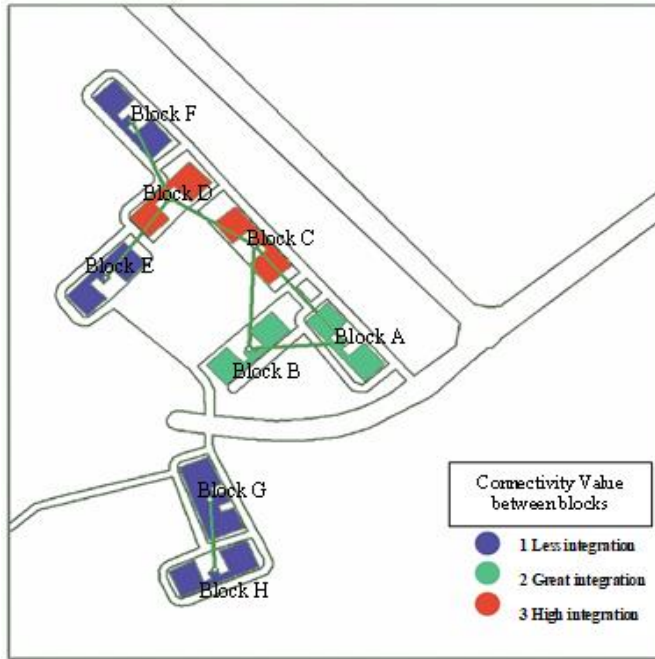
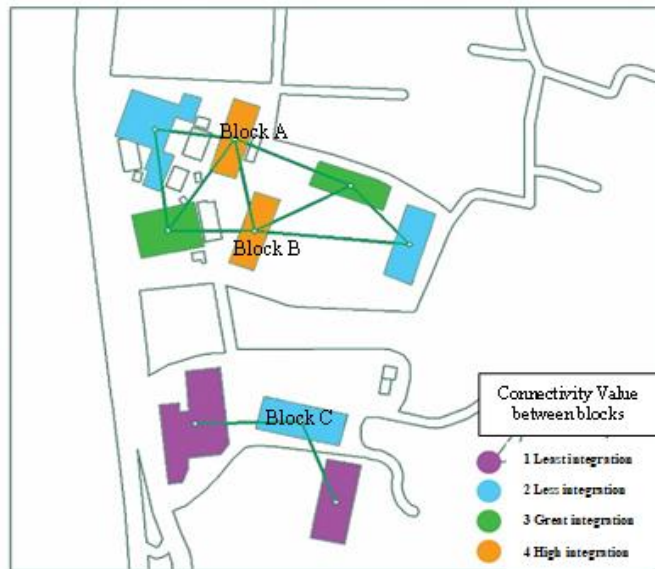**a. Single isovists mapping of PPR Kampung Baru Air Panas.**
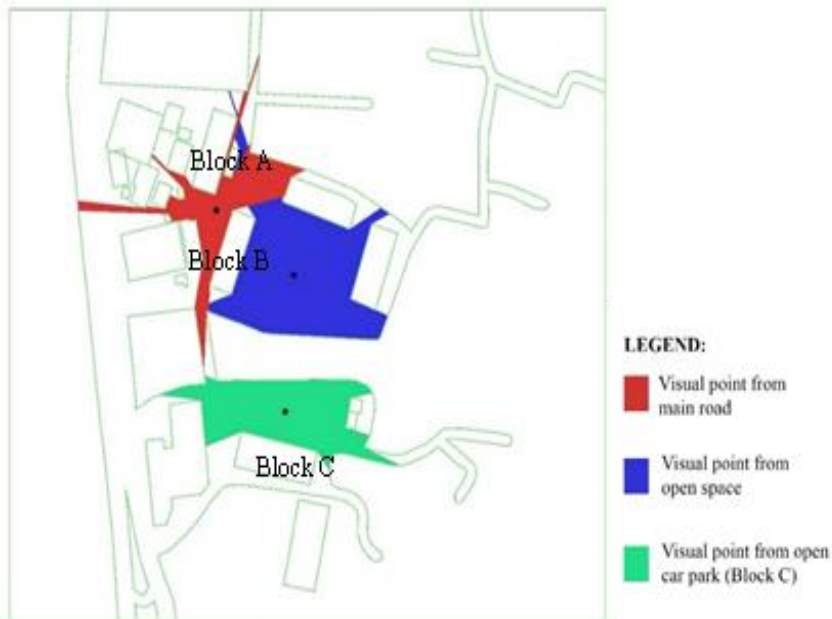
b. Single isovists mapping of Public Housing Sri Kelantan.

**Fig. 5. Results of a single Isovist mapping
showing the visual potentiality of public housing.**

(a) Convex map analysis of PPR Kampung Baru Air Panas.

(b) Convex map analysis of Public Housing Sri Kelantan.

Fig. 6. Results of convex map analysis of public housing.

The public housing in Sri Kelantan yielded four different connectivity values, as shown in Fig. 6(b). Blocks A and B exhibited the highest integration and connectivity among the residential blocks. These blocks were situated near the

main roads and connected to nodes such as commercial stalls and the prayer hall. This higher integration of the area is associated with a lower likelihood of crime.

In contrast, according to the analysis, Block C in public housing Sri Kelantan exhibited a lower integration value. This block is accessed through an underneath road, resulting in a lack of connection with Blocks A and B. Based on the integration analysis, it can be inferred that Blocks A and B have greater permeability between spaces and higher potential for circulation connectivity compared to Block C. Consequently, Blocks A and B have a lower crime probability than Block C.

4. Conclusion and Recommendation

It is evident that the themes derived from the analysis of spatial layout design, particularly visibility and accessibility, significantly contribute to the sense of safety as revealed through the space syntax study. Thus, the evidence obtained from the present study provides insights into the factors associated with existing spatial configurations that influence crime rates within residential areas, as explored through the space syntax study. The application of space syntax and Isovist mapping facilitates the identification of visibility patterns and potentially dangerous zones, which are closely related to the occurrence of crime. Enhanced visibility indicates a higher level of human presence and is, therefore, a crucial consideration in ensuring the safety of occupants when designing housing layout arrangements.

Moreover, the mean depth analysis revealed the difficulty pedestrians encountered in reaching their destinations are related with an increased risk of break-ins. Local movement patterns can help mitigate this risk, emphasising the importance of planning to facilitate local movements while minimising larger-scale movements. Alternatively, residential areas should strike a balance by providing an appropriate level of permeability that allows movement in all directions, as an excessive provision of underutilised permeability poses a criminal risk.

The study findings showed that PPR Kampung Baru Air Panas demonstrates a greater potential for circulation due to its enhanced visual information and physical accessibility compared to public housing Sri Kelantan. Consequently, the organisation of the existing layout plays a crucial role in effectively controlling crime occurrences. However, it is essential to note that Blocks F, G, and H in PPR Kampung Baru Air Panas exhibit poor integration and connectivity to the public. The presence of dead-ends and blind spots in these areas increases the likelihood of crime. Nevertheless, it is worth noting that the blocks closer to the main road, with only one access point, tend to be safer.

In contrast, public housing in Sri Kelantan presented more significant challenges in controlling crimes due to its existing physical environment. The surrounding conditions posed difficulties in terms of readability and visual access. For instance, the space syntax study revealed that the dispersed blocks in public housing in Sri Kelantan had varying visual integration, creating opportunities for criminals to enter unnoticed easily. Additionally, the complex circulation patterns within the housing area allowed criminals to hide, further reducing the chances of detection by residents. Consequently, such a setting became more conducive to criminal activities.

In conclusion, both the studied public housing developments exhibited high crime rates. Each housing complex had a distinct spatial typology characterised by interconnected or dispersed layouts, leading to different levels of safety in their respective physical environments. The medium and high possibilities of crime in both public housing developments validated the reported high crime rates. Therefore, the findings from both public housing complexes strongly indicated that the space syntax approach, which explored three-dimensional spatial design factors, provided valuable insights into the occurrence of crime. Hence, the space syntax study proved a suitable method for evaluating and predicting crime occurrence in public housing.

In summary, this study focused on the crime issue and investigated safety considerations related to circulation connections and the layout of blocks within public housing complexes. Based on the preceding analysis and the development of an ideal model, several recommendations were proposed to enhance security in the physical environment. These recommendations included selecting appropriate configurations that prioritised space security as summarised in Table 4.

Table 4. Recommendations to enhance a sense of safety in Public Housing according to the Space Syntax Analysis.

	Recommendations
Visibility Graph Analysis (VGA)	• Reducing the obstruction, such as tall trees in the blind spots and surrounding blocks. • Proper arrangement of the features and variety of urban indications to prevent visually inaccessible locations. • A sufficient distance between the blocks allows greater visibility of the occupants within the area.
Isovist Mapping	• Use suitable lighting at night with adequate all sites and surrounding areas. • The dead-end edges and corners should include visual accessibility as much as possible. • Creating a guarded space in the areas where blind spots are apparent.
Integration Analysis Graph	• Installing active surveillance across the building, open space, and inaccessible areas to provide relative security.

Limitations and suggestions

The primary limitation to the generalisation of the results is that the study was focused on only two selected case studies in Kuala Lumpur, which does not encompass other districts in Malaysia. This limitation arose due to time restrictions and the feasibility of the workload. Furthermore, the study is constrained by the observation of specific spatial typologies and the existing physical environmental design of public housing, as it was conducted within a limited observation period. Consequently, the results should not be generalised to other types of investigations.

Moreover, a notable limitation of the method used in this study is the space syntax technique, which is primarily employed as a predictive tool to assess crime

opportunities in the design of the physical environment. As a result, the findings may not accurately represent reality, as other factors and considerations were not addressed in this study. For instance, site location in congested urban areas or suburbs could also influence the likelihood of crime occurrence.

In summary, it is important to acknowledge that this study focused on the sense of safety in public housing and was limited in its ability to cover various aspects. These aspects should be considered for future research endeavours that seek to provide a more comprehensive understanding of the topic.

References

1. White R.D.; Haines, F.; and Asquith, N.L. (2017). *Crime and criminology.* Oxford University Press, Melbourne.

2. Department of Statistics Malaysia. (2016). Social Statistic Bulletin Department of Statistics Malaysia. Retrieved October 5, 2022, from https://www.dosm.gov.my/portal-main/release-content/social-statistics-bulletin-malaysia-2016

3. Department of Statistics Malaysia. (2021). Crime Statistics Publication. Retrieved October 5, 2022, from https://www.dosm.gov.my/

4. Puah, C.H.; Voon, S.-L.; and Entebang, H. (2009). Factors stimulating corporate crime in Malaysia. *Economics, Management and Financial Markets,* 4(3), 87-99.

5. Vandeviver, C.; and Steenbeek, W. (2019). The (in) stability of residential burglary patterns on street segments: the case of Antwerp, Belgium 2005-2016. *Journal of Quantitative Criminology*, 35(1), 111-133

6. Chiew, L.S.; Amerudin, S.; and Yusof, Z.M. (2020). A spatial analysis of the relationship between socio-demographic characteristics with burglar behaviours on burglary crime. *IOP Conference Series: Earth and Environmental Science*, 540(1), 01250.

7. Marzuki, F.N. (2016). Public housing projects becoming crime haunts. The Star. Retrieved August 2022, from https://www.thestar.com.my/news/nation/2016/06/10/public-housing-projects-becoming-crime-haunts

8. Ali. S.N.M.; Tarmidi, Z.; Maimun, N.H.A.; Noor, N.A.M.; Hassan, N.; Sidek, A.; Nasir, A.N.M.; and Ramly, Z.M. (2022). Assessing safety level of affordable housing based on safe city concepts. *IOP Conference Series: Earth and Environmental Science*. 1064(1), 012013.

9. Clarke, R.V.G.; and Felson, M. (1993). *Routine activity and rational choice*. Transaction publishers.

10. Summers, L.; and Johnson, S.D. (2017). Does the configuration of the street network influence where outdoor serious violence takes place? Using space syntax to test crime pattern theory. *Journal of Quantitative Criminology*, 33(2), 397-420.

11. Jones, M.A.; and Fanek, M. (1997). Crime in the urban environment. *Proceedings of the 1ˢᵗ International Space Syntax Symposium*, London, 25, 1-11

12. Mahdzar, S.S.S; Jaberolansar, S.; and Saari, N.S. (2017). Reducing fear of crime through spatial configuration analysis for urban sustainability in mixed-use neighbourhood. *Journal of Biodiversity and Environmental Sciences*. 11(5), 161-168.

13. Loukaitou-Sideris, A.; and Eck, J.E. (2007). Crime prevention and active living. *American Journal of Health Promotion*, 21(4s), 380-389.

14. Awtuch, A. (2009). Spatial order and security: Case study of two housing estates. *Proceedings of the 7th International Space Syntax Symposium*. Stockholm, 005:1-005:10.

15. Bendjedidi, S.; Bada, Y.; and Meziani, R. (2018). Open spaces: spatial configuration, visibility analysis and use case study of mass housing in Biskra, Algeria. *International Review for Spatial Planning and Sustainable Development*, 6(4), 93-109.

16. Heidari, A.A.; and Gastasebi, N. (2019). Analysis of residential complexes with the approach of space syntax in terms of mass crime (Case Study: Shiraz residential complexes). *International Journal of Architecture and Urban Development*, 9(3), 11-20.

17. Hillier, B. and Sahbaz, O. (2005). High resolution analysis of crime patterns in urban street networks: an initial statistical sketch from an ongoing study of a London borough. *Proceedings of 5th International Space Syntax Symposium*, Delft, 451-478.

18. Mahdzar, S.S.S.; Jaberolansar, S.; and Hakim, A. (2019). The effect of spatial configuration on sense of safety through street legibility. *Proceedings of the 12th Space Syntax Symposium*, Beijing, China, 1-9.

19. Othman, F.; Yusoff, Z.M.; and Salleh, S.A. (2019). Identifying risky space in the neighbourhood: an analysis of the criminogenic spatio-temporal and visibility on layout design. *Environment-Behaviour Proceedings Journal*, 4(12), 249-257.

20. Shu, S.C.F.; and Huang, J.N.H. (2003), Spatial configuration and vulnerability of residential burglary: A case study of a city in Taiwan. *Proceedings of the 4th International Space Syntax Symposium*. London, 1-17.

21. Hillier, B.; and Shu, S. (2000). *Crime and urban layout: The need for evidence*. In Ballintyne, S., Pease, K. and McLaren, V. (Eds), *Secure Foundations: Key Issues in Crime Prevention*. Crime Reduction and Community Safety, Institute of Public Policy Research, London, 224-48.

22. Lynch, K.; and Hack, G. (1984). *Site planning*. (3rd ed.). MIT press.

23. Hillier, B. (1996). Cities as movement economies. *Urban Design International*, 1(1), 41-60.

24. Yamu, C.; Nes, A.V.; and Garau, C. (2021). Bill Hillier's legacy: Space syntax - A synopsis of basic concepts, measures, and empirical application. *Sustainability*, 13(6), 3394.

25. Hillier, B.; and Hanson, J. (1984). *The social logic of space*. Cambridge: Cambridge University Press.

26. Benedikt, M.L. (1979). To take hold of space: isovists and Isovist fields. *Environment and Planning B: Planning and Design*, 6(1), 47-65.

27. Newman, O. (1996). *Creating defensible space*. US Department of Housing and Urban Development, Office of Policy Development.

28. Andrage, A.D.; Pont, M.P.; and Amorim. L. (2018). Development of a measure of permeability between private and public space. *Urban Science*, 2(3), 87.

29. Lewis, S. (2005). *Front to back: A design agenda for urban housing*. (1st ed.) Architectural Press, Routledge.

30. Ismail, A.S.; Mohidin, H.H.B.; and Daud, M.M. (2017). A review on occupants' satisfaction and wellness level in low-cost housing in Malaysia. *Planning Malaysia Journal*, 15(3), 147-158.

31. Dalton, R.; Dalton, N.; Peverett, I.; Clinch, S.; and Davies, N. (2015). Using laser scanning to produce 3D isovists of real environments. *Proceedings of the 10th International Space Syntax Symposium*. London: University College London.

32. Beck. M.P. (2015). Slicing the cake: An Isovis t-based analysis of computerised workplace configuration. *Proceedings of the 10th International Space Syntax Symposium*. London: University College London.

33. Turner. A.; Doxa. M..; O'Sullivan. D.; Penn, A. (2001). From isovists to visibility graphs: A methodology for the analysis of architectural space. *Environment and Planning B: Planning and Design*, 28(1), 103-121.

34. Griz, C.L.; and Amorim, L. (2015). When luxury is necessary. Apartment projects in Recife – Brazil. *Proceedings of the 10th International Space Syntax Symposium.* London: University College London.

35. Lis. A.; Pardela. L.; Can. W.; Katlapa. A.; and Rabalski, L.R. (2019). Perceived danger and landscape preferences of walking paths with trees and shrubs by women. *Sustainability*, 11(17), 4565.

36. Badiora, A.I.; Wojuade, C.A.; and Adeyemi, A.S. (2020). Personal safety and improvements concerns in public places: An exploration of rail transport users' perception. *Journal of Place Management and Development*, 13(3), 319-346.

37. Kozlova, L.V.; and Kozlov, V.V. (2017). Principles of improvement of large city public space (by example of Irkutsk City). *IOP Conference Series: Materials Science and Engineering*, 262, 012228.

38. Groat, L.N.; and Wang, D. (2013). *Architectural research methods.* John Wiley & Sons.