Space Syntax as a Method to Improve the Space Quality of Future Low-income Housing (L-iH) in Malaysia

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This paper highlights the role of Space Syntax as a method to analyze spatial quality in Low-income Housing (L-iH) in Malaysia. Low-income Housing (L-iH) schemes such as the People's Housing Project (PPR) have been one of the government's approaches in coping with housing shortage in the Klang Valley. These L-iH schemes have been reported to be unsatisfactory to the inhabitants' comfort, social and cultural needs. It is therefore crucial to investigate the relationship between space and the occupants by assessing the indoor space visibility using Visual Graph Analysis (VGA) as part of Space Syntax method, as the analytical tool to improve the future designs of L-iH that will benefit the occupants, policymakers, low-income house developers and consultants, researchers in the architecture field, and society at large.

Keywords: Low-income Housing, Spatial quality, Space Syntax, Visibility, Visibility Graph Analysis (VGA)

1. INTRODUCTION

As a fast-developing country in the Southeast Asia, Kuala Lumpur being the central business district in Malaysia attracts over seven million residents. The ever-growing population has been rapidly increasing since the 1980s. As a result, Greater Kuala Lumpur is witnessing slum areas and unsettled urban dwellers issue. In order to improve this scenario, the government have made an effort to provide housing schemes for the low-income group called the People's Housing Project (PPR). These PPR(s) are designed to be in the form of high-rise flats, with 13-storeys and 20 living units per floor as land is scarce. According to CIDB (1998) the low-income living units measured to about $63m^2$ fitting a kitchen, living and dining area, 3-bedrooms and 2 toilets. However, despite the effort by the government to provide housing for the low-income group, most of the studies in the literature mentioned a lack of space consideration given towards L-iH (Nor Haniza Ishak et al., 2016; Razali & Talib, 2013; Wahi et al., 2018). Khazanah Research Institute (2019) also mentioned that the current PPR housing design is inadequate and still does not cater to its occupants' basic needs. The housing environments and the quality of spaces within it could influence the quality of life of its occupants (Bakar et al., 2016; Mohit et al., 2010; Mohit & Nazyddah, 2011). Therefore, this study explores occupants-space relationship and identified the level of visibility of spaces within the L-iH living units.

To date, there are 55 PPR L-iH projects by the government. However, only 27 PPR L-iH were constructed after the enactment of new housing policy (Suryadi et al., 2022; Suryadi et al., 2022b). From the 27 units, only 2 are of 3-bedroom typology and they were the two most recent PPR built by DBKL. The two PPRs are regarded as the second generation of PPR. To accommodate to the aim of this paper, the study was conducted on the most recent PPR housing which is the second generation of the government's L-iH typology since its initiation in the year 1999. As the PPR were designed to be of typical layout or template-based, thus only one PPR will be studied. Among these two types of 3-bedrooms living units' design, the PPR Sentul Murni is latest design scheme constructed by DBKL (Suryadi et al., 2022; Suryadi et al., 2022b).

2. LITERATURE REVIEW

In Malaysia, despite continuous effort by the government to improve the quality of life of low-income people by providing the low cost housing, the current L-iH design has not achieved the overall satisfaction of its occupants (Mohamad et al., 2018). According to the Department of Statistics Malaysia (2020), there are generally five members in a typical Malaysian family or household, which creates occupancy by room or space between two to six individuals. This situation generates privacy issues within a family as ideally a house should accommodate not more than four members for efficiency in terms of privacy (Nor Haniza Ishak et al., 2016; Tee & Goh, 2010). Scholars have noted that the occupants of the low cost housing considered the spaces to be insensitive towards their living pattern and privacy (Suryadi et al., 2022; Mohd Salleh, 2020; Goh and Ahmad, 2011). This was then supported by Razali and Talib (2013) through an investigation of privacy in the Islamic point of view and gender privacy in low cost housing, specifically the PPR within Kuala Lumpur, through space planning.

The concept of privacy seen as a basic human need inserted in psychological and social concepts, implies delving into discussion related to different fields of knowledge, particularly in studies related to behaviour and its built environment (Mohd Razali & Talib, 2018). According to Ferreira De Macedo et al. (2021), since the separation of private and public life in the seventeenth century, the house has been regarded as the centre of private life. A house is a symbolic place that provides ideals of domesticity, comfort, and well-being through privacy (Al-Jokhadar & Jabi, 2020). Houses should provide acceptable levels of visual privacy to ensure privacy and intimacy within the house. Thus, spaces within a house should be organised to provide the privacy possible, and the spatial structure of the house is dictated by the need for privacy of the occupants (Ali Mustafa et al., 2010; Alitajer & Molavi Nojoumi, 2016). Past studies by Zalloom (2019), Gou et al. (2018) and Karim (2012) also addresses that it is significant to consider the visual privacy factors in house design. Visual privacy is defined as the ability to carry out everyday activities hidden from outsiders' eyes (Alitajer & Molavi Nojoumi, 2016). Therefore, the house must be designed and built to provide visual privacy and better quality of living conditions for its occupants.

In architecture, it is crucial for the designer to understand the nature of the spaces to improve the living experience within the housing units, and this includes low-cost houses as well. In normal circumstances, such understanding will be gained through use perception analysis which will usually intrude even further into the livelihood of the occupants. As the solution to this, this study suggests the analysis of such study could be done remotely without the interference of any human interpretation or perception in accessing the interior environment of private houses to improve design quality. This can be done successfully by using VGA analysis as one of the Space Syntax analysis to further understand the current spatial quality of the L-iH within Kuala Lumpur effectively to improve the future PPR that the government will then design in the future. Insofar, the use of the space syntax analysis was mainly applied to research into the urban structure (Hidayati et al., 2021; Othman et al., 2020; Mansouri & Ujang, 2016; Salwa et al., 2014). Application of Space Syntax in the context of residential typology was done by Yahaya (2018) where he compared and studied the spatial configuration with regard to the L-iH in Johor on Malay traditional houses according to the static activities of the occupants. This research will focus on the application of Space Syntax, through Visual Graph analysis (VGA), as a means of understanding the current L-iH spatial quality as part of the contribution towards improving the quality of living by the occupants of future L-iH. Space Syntax analyses can accurately test and measure the level of visibility that exist in the design even before it is built until a satisfactory design can be achieved economically without involving any cost of building these houses for the future occupants.

3. METHODOLOGY

The Visual Graph Analysis (VGA) is one of the Space Syntax methods. This method quantitively measured the social and cultural data exist in the floor plan by translating the floor plan into a numerical form of data. The VGA graph is developed with the cells as its nodes and visibility between cells as its edges. This visibility graph has a low level of abstraction because every node represents an actual point in space. The main purpose of the VGA analysis conducted is to assess the spatial visibility within spaces exist in a spatial system which are the PPR Sentul Murni living unit.

Next, The PPR Sentul Murni is selected as a case study. This is because the PPR Sentul Murni is the latest low-cost housing under the *Program Perumahan Rakyat (PPR)* in Kuala Lumpur territory that completed it construction in 2012. The significant of selecting the PPR Sentul Murni is because, firstly, the Program Perumahan Rakyat (PPR) is the most well-known and successful low-cost housing project by the government that has been constructed in Malaysia since 1999.

Next, Through the literature and DBKL list of PPR housing projects, the study identified the most recent PPR Low-cost housing design are the 3-bedroom living units. Besides, the study also discovered the latest space design standard for Low-cost housing which is the Construction Industry Standard 2 established by (Lembaga Pembangunan lndustri Pembinaan Malaysia (CIDB), 1998). Therefore, to investigate the recent Low-cost housing space design standard, the study limits the selection of PPR low-cost housing projects that are constructed from 1999 onwards. Thus, the study only includes 27 PPR projects out of 55 PPR projects at this stage.

Since the nature of the study would only examine and analyse the internal L-iH living unit space configuration, at this stage, the study eliminated the PPR project with a similar living unit space configuration design. The PPR L-iH design is a template-based design by the authority. Thus, among the 27 PPR L-iH projects, the study discovered there are only two types of 3-bedrooms Low-cost housing living unit's layout under the PPR housing scheme. Among these two types of 3-bedroom living units design, the PPR Sentul Murni is latest design scheme constructed by DBKL.

3.1. Findings- VGA analysis

The space layout of the of PPR Sentul Murni living unit is shown in **Figure 1**. The study first set up the grid of 100mm X100mm in the DepthmapX to calculate the dimension of the spaces in the living unit. Next, the study segmented the spaces in the living unit based on the design intend space function The spaces in the living unit PPR Sentul Murni into 10 spaces. In this analysis, each of the spaces is defined as a 'node' **(refer to figure 1)**.

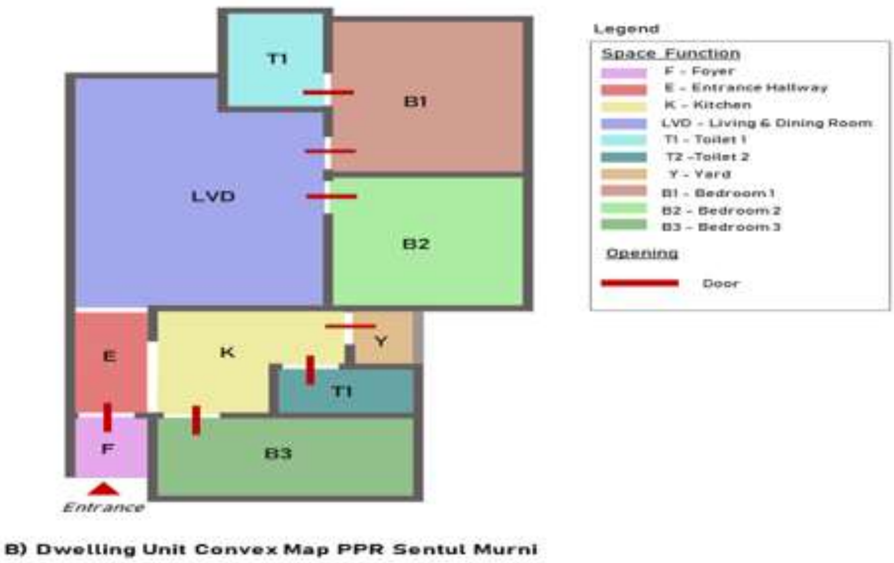

Figure 1: Ten (10) spaces segmentation of PPR Sentul Murni Living unit

Figure 2 shows the Visual Graph Analysis measure how visually integrated each space from all immediate spaces. High value is present in red and low value present in blue. The higher the value, it means the more visually integrated and the lower the value, the more visually segregated. All the data extracted from the graph are recorded into the table and the data is divided into three (2) category of visual integration, minimum and maximum. Data findings for the minimum visual integration and connectivity of all indoor spaces in living unit is recorded in the Table 1.

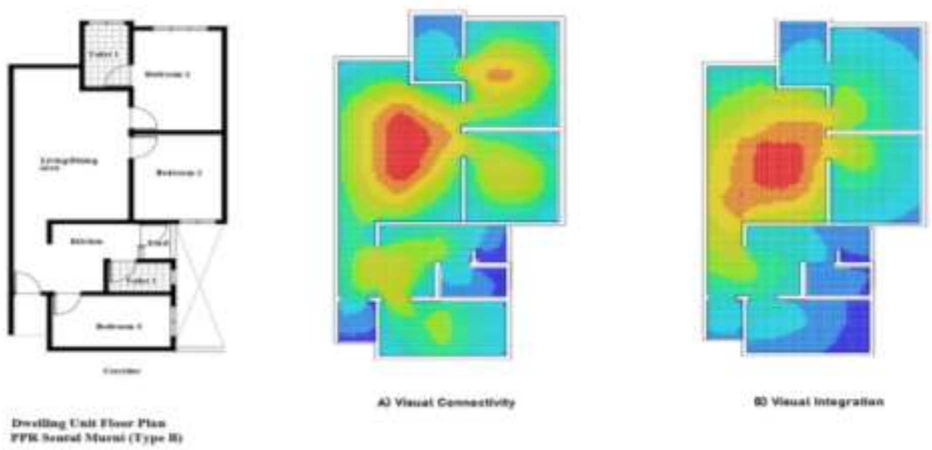

Figure 2: VGA Map of PPR Sentul Murni Living unit, a) visual connectivity and b) visual integration of PPR Sentul Murni living unit

Table 1: Minimum Spatial Visibility value of all indoor spaces of PPR Sentul Murni living unit

Parameters	Spaces / nodes Foyer (F)	Entrance Hallway (E)	Living & Dining Room (LVD)	Bedroom 1 (B1)	Bedroom 2 (B2)	Bedroom 3 (B3)	Kitchen (K)	Yard (Y)	Toilet 1 (T1	Toilet 2 (T2)
Visual Connectivity Value	196	435	334	334	334	326	294	166	264	196
Visual Integration Value	2.83	3.81	3.55	2.81	2.92	2.38	2.96	2.31	2.71	2.31

The data finding of the minimum visual connectivity is recorded in the **Table 1**. As presented in the table, the node E has the highest minimum connectivity value of 435, followed by the node LVD, B1, B2 and B3 shared minimum visual connectivity value of 334. Node B3 ranked in the fifth (326), followed by node K in sixth (294) and node T1 (264) in seventh rank. The node F and T2 shared minimum visual connectivity value of 196. The space that has the least minimum visual connectivity value is node Y.

The data finding for minimum visual integration value is recorded in **Table 1** above. As shown in the table, the minimum visual integration value of node E (3.81) is the highest, followed by the node LVD (3.55). In the third rank is node K with minimum visual integration value of 2.96 and in fourth rank is node B2 with value of 2.92. Node F ranked in the fifth with value of 2.83 and followed by node B1 and T1 with integration value of 2.81 and 2.71 respectively. The space that has the least minimum visual integration value is node T2 with 2.31.

Table 2: Maximum Spatial Visibility value of all indoor spaces of PPR Sentul Murni living unit

Parameters	Spaces / nodes Foyer (F)	Entrance Hallway (E)	Living & Dining Room (LVD)	Bedroom 1 (B1)	Bedroom 2 (B2)	Bedroom 3 (B3)	Kitchen (K)	Yard (Y)	Toilet 1 (T1	Toilet 2 (T2)
Visual Connectivity Value	555	866	1232	1050	884	849	869	451	830	486
Visual Integration Value	3.40	5.43	6.40	5.32	5.44	5.95	4.64	2.98	3.69	3.08

The data finding of the maximum visual connectivity is recorded in the **Table 2**. As shown in the table, maximum visual connectivity value of node LVD is the highest (1232), followed by node B1 (1050). In the third rank is node B2 with value of 884, followed by node K in the fourth with value of 869. Node E and node B3 ranked in sixth and seventh with value of 866 and 849 respectively. The node with the least moderate visual connectivity value is node T2 and Y with value of 486 and 451 respectively.

The data finding for maximum visual integration is recorded in the **Table 2**. As presented in the **table 2**, node LVD has the highest maximum integration value of 6.40, followed by node B3 with 5.95. In the third rank is node B2 with maximum integration value of 5.44 and in the fourth rank is node E with value of 5.43. Node B1 ranked in fifth with value of 5.32 and followed by node K, T1 and F with maximum integration value of 4.64, 3.69 and 3.40 respectively. The space that has the least maximum integration value is node Y with value of 2.98. Therefore, in these findings, the space living, and dining room is most visually integrated among other spaces in the living unit spatial system. On the contrary, the toilet 2 and yard of the dwelling are spaces with the least maximum visually integrated among other spaces.

To identify the pattern and trend of the data findings, the spatial visual distribution of each space in the case study is calculated. The sum of minimum and maximum for both visual connectivity and integration value were calculated. **Table 3** shows the spatial visual distribution for both visual connectivity and integration value.

Table 3: Results of visual integration distribution of PPR Sentul Murni Living unit

Spaces / nodes	Total Visual Connectivity Value (min. + max)	Visual Connectivity Distribution (%)	Total Visual Integration Value (min. + max)	Visual Integration Distribution (%)
Foyer (F)	751	7	6.23	8
Entrance Hallway (E)	1301	12	9.24	12
Living & Dining Room (LVD)	1566	14	9.95	13
Bedroom 1 (B1)	1384	13	8.13	11
Bedroom 2 (B2)	1218	11	8.36	11
Bedroom 3 (B3)	1175	11	8.33	11
Kitchen (K)	1163	11	7.6	10
Yard (Y)	617	5	5.29	7
Toilet 1 (T1)	1094	10	6.4	9
Toilet 2 (T2)	682	6	5.39	7
Total		100	74.92	100

In **Figure 3**, the living and dining room (LVD) has the highest overall visual distribution among other spaces in the living unit with 14% of visual connectivity distribution and 13% visual integration distribution. The Entrance Hallway (E) has the second highest spatial visual distribution with 12% of both visual connectivity and integration value. The Bedroom 1 (B1) also has the second highest spatial visual distribution with 13% of visual connectivity distribution and 11% visual integration distribution. Therefore, Entrance Hallway (E) and Bedroom 1 (B1) ranked in second among other spaces in the living unit. The other spaces like Bedroom 2, Bedroom 3 and Kitchen has the moderate overall visual distribution within spaces in the unit with 11% of visual connectivity distribution and 11%, 11% and 10% visual integration distribution respectively. The yard has the lowest overall visual distribution among other spaces in the living unit with 5% of visual connectivity distribution and 7% visual integration distribution. This data shown that living and dining room has the most spatial visibility in the unit and followed by entrance hallway and bedroom 1. Conversely, the yard has the least spatial visibility within other spaces in the living unit.

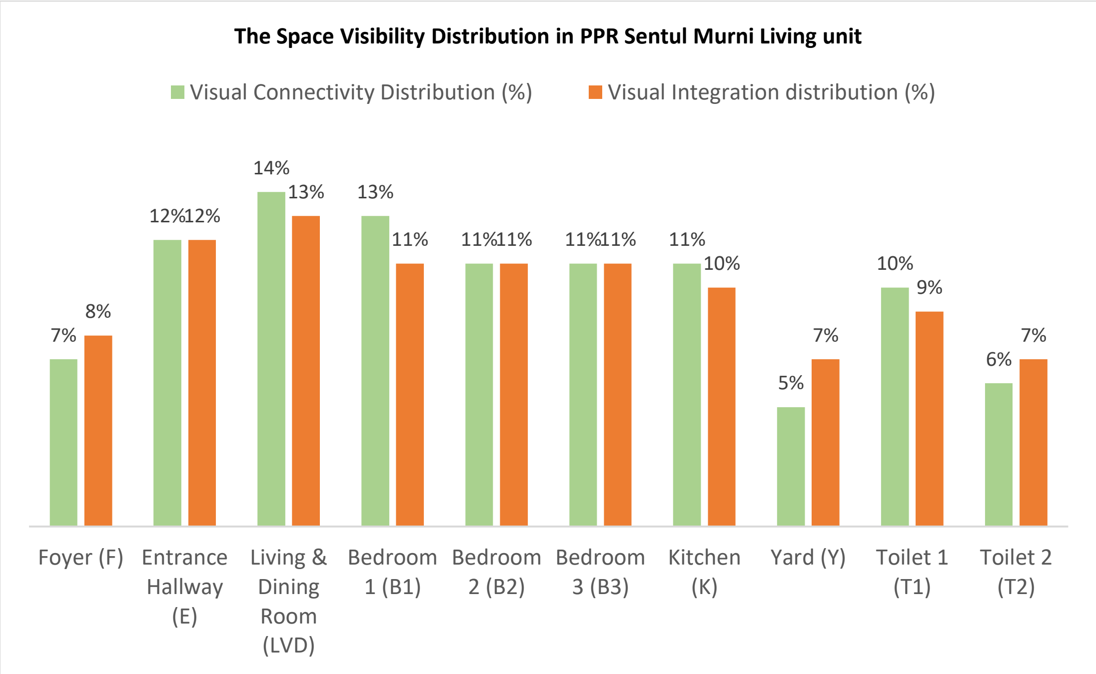

Figure 3: Space visibility distribution within the PPR Sentul Murni Living unit

4. DISCUSSION

This study showed that, the most visible spaces are the common spaces in the living units. Common space is defined as a space used by all the household members in the living units. This study found that, in the PPR, the living and dining area are the most visible spaces in the living unit, among other spaces in both living units. Hillier & Hanson (1984) mentioned that people tend to path their ways according to their visibility. Therefore, the high visibility spaces can be interpreted as spaces with most accessibility and permeability (Zerouati & Bellal, 2019). Thus, the living and dining area are most permeable and easily accessible spaces among other spaces in both living units.

According to Alitajer & Molavi Nojoumi (2016), space with the highest visual connectivity and integration value has the least visual privacy. However, for PPR Sentul Murni, bedroom 1 has the second most spatial visibility among other spaces in the spatial system. Nevertheless, the high integration and connectivity value in the living room occurs because of its direct connection with the doors of the bedrooms in both living units. Therefore, in other words, once the door opens, the inside of the bedrooms will be visible from the outside (living and dining room) and thus affect the privacy of those who are inside. These also explained that the visual integration and connectivity value of bedrooms 1 and 2 in both living units are among the highest compared to other spaces. Having direct visibility from the common space (living and dining room) to the private space (bedroom) is a concern as the bedroom is a sacred space in a house. Spaces within house should be organised to provide the greatest amount of privacy possible and the spatial structure of the house is dictated by the need for privacy of the occupants (Ali Mustafa et al., 2010; Alitajer & Molavi Nojoumi, 2016). Therefore, the bedrooms and living area should not be directly visually connected to provide better visual privacy within the common space and private space. Thus, this study found no considerations regarding visual privacy within spaces in low-income living units, especially within the bedrooms and the living and dining rooms. Through this study, it is clear that space can be understood, simulated and adjusted to achieve the maximum level satisfaction required by the occupants.

5. CONCLUSION

This study provides an exciting opportunity to advance the knowledge of space structure and its quality in Low-income housing in the built environment research as the study analysed the visibility of space of the current low-income housing design with relation to its occupant's by using a unique analytical tool that is the Visual Graph Analysis via Space Syntax Analysis.

The study had selected PPR Sentul Murni as it is one of the latest versions of PPR flats in Kuala Lumpur. This data is intended to be used as the benchmark for future PPR housing built for the usage of the low income earners as it outlines the quality and value of the spaces using Space Syntax Analysis in a more systematic way even during designing stage which is deemed to be much more effective and economical.

The study is hoped to improve the future designs of Low-Income Housing and it will benefit not only policymakers, low-income house developers and consultants, researchers in the architecture field, but the intended community at most.

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