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Analysis of Justified Plan Graphs on Subsidized Flats in DKI Jakarta

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ABSTRACT

The Justified Plan Graph (JPG) is a technique developed in the late 1970s and developed for 20 years as a means to do qualitative and quantitative research especially for spatial structure or permeability of buildings. With JPG, we can study the economic-socio-cultural conditions of the occupants. For example, the location of the balcony with a deep step depth shows that the space is a private area for hanging clothes out for drying. It also shows that clothes dryers are not yet popular among residents. The government of DKI Jakarta is currently building many subsidized flats to solve the housing stock problem. There are 15 residential unit layout types; each resident unit layout consists of 1 living room, 2 bedrooms, 1 kitchen, 1 bathroom and 1 laundry room. This research purpose to find out the JPG of 5 types of resident unit layout (random sampling) whether there is sameness. If there is sameness, can we use it for our reference in the next similar design process? The conclutions are, it was found that 3 of 5 JPG layouts are the same. The JPG answered a busy life DKI Jakarta residents which needs a compact layout with a little step depth (high integration values) to makes it easier for them accesing all rooms and being multitasking easily.But it doesn't mean that is is a genotype. Because the JPG is only examined on 5 residential unit layouts and there are still 10 residential unit layouts which have not been researched yet. That is why it is recommended to do the similar research for other residential unit layouts in DKI Jakarta subsidized flats. So that if there is a genotype (consistent JPG) of most of all the residential unit layout, there could be a guidance for architect in designing similar projects in future.

Keywords: *integration value, justified plan graph*

1. Introduction

1.1. Background and Problem Statement

Problems that often occur in urban areas are high birth rates and urbanization and limited urban land and makes its value increase. It results in a lack of housing supply for urban population, especially the lower middle class [19]. To overcome these problems, the DKI Jakarta Government has built a number of subsidized flats in various places.

Justified Plan Graph (JPG) is a method of Space Syntax which is used to understand the spatial configuration in a built environment.[1][2][4][6][8][9][10][15] It can be said that there is a strong genotype in that built environment if same JPG patterns are found in most of built environments in a particular region or culture [5][6][7][11][12].

By studying the JPG of a residence in a certain area, we can learn the values, culture and behavior of that community who live there[3][12]. For example, in apartments in Seoul (Korea), it was found that the highest *integration value* was found in the living room. It turns out that this room is the center (core) of the residence and replaces the "Hanok" in traditional Korean houses [18]. Another example is the JPG analysis of 5

residences designed by Glen Murcutt (Pritzker Prize winner) in 1975-1982 [13]. A fairly strong genotype was found which shows that the hallway (alley) has the highest *integration value*, followed by the dining room. Based on these findings, it can be concluded that the dining room is the center (core) of Glen Murcutt's residences at that period [16]. Another example is genotype research on Sumbanese traditional houses. It is known that the kitchen has the highest *integration value* and it turns out that Sumba adheres to the "Marapu" belief system (dead ancestors still live side by side with those who are still alive). Through certain ceremonies, they can connect with their ancestors in the kitchen ("Rabok"). Therefore, this room becomes the center (core) of their residence [11].

Designing subsidized flats in urban areas, especially DKI Jakarta, is a complex job, because the residents are multi-cultural, so a deeper understanding is needed to accommodate the space needs of their diverse customs, cultures and habits. Until now, flats are still an alternative solution to overcome the problem of dense housing in urban areas [20]. This was also chosen by the DKI Jakarta Government to solve housing problems, especially for the lower-middle economic class people. The lots of subsidized flats developed in DKI Jakarta raises the question, what is the JPG of these residential units? Are there any similarities between the JPG patterns? If so, why? could the JPG use as a reference in designing residential unit plans for similar DKI Jakarta subsidized flats in future?

1.2. Problem Solving Approach

This research seeks to reveal whether the spatial organization pattern of 36m^2 residential units in several subsidized flats in Jakarta have a certain consistency through Justified Plan Graph (JPG) analysis.

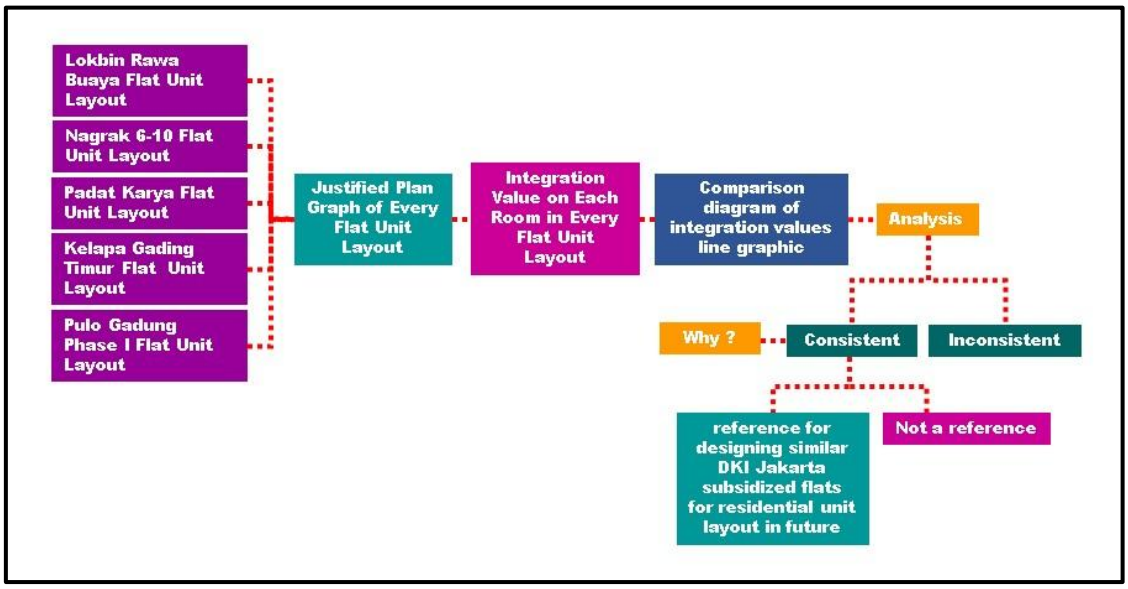

Figure 1. Problem Solving Approach Diagram
Source: Author, 2024

In order to answer those questions, it is necessary to conduct study of the residential unit layouts in selected subsidized flats using the space syntax theory and with the help of Justified Plan Graph (JPG) so that it could be find out whether there is a consistency (or not) between the JPGs. Further explanation can be seen in the figure 1 above. If the main JPG has found, the research continue to find out why is it happened? Can the main JPG applied in many similar subsidized flats in DKI Jakarta for the next projects?

2. Method

2.1 Sampling

There are about 30 subsidized flats (but only 15 residential unit layout types) built in 2012-2022 by DKI Jakarta Government. In this research, 5 residential unit layouts of them were selected. They are ±36m^2 unit area, consisting of 1 Living Room, 2 Bedrooms, 1 Bathroom, 1 Kitchen and 1 Laundry Room. Primary data (selected 5 residential unit layouts) was obtained through the SIRUKIM (Housing and Settlement Information System) application issued by the DKI Jakarta Provincial Government [21]. The chosen subsidized flats are

Lokbin Rawa Buaya Flat, West Jakarta, Nagrak 6-10 Flat, West Jakarta, Padat Karya Flat, West Jakarta, Kelapa Gading Timur Flat, East Jakarta and Pulo Gadung Flat Phase-1, East Jakarta.

2.2. Redrawing the residential unit layout

The redrawing of the residential unit layout of selected subsidized flats is to simplify the room organizations. The scale of the layout and the thickness of the walls are adjusted, the windows are deleted but the room names are still the same (Figure 2). It makes the layout more simple cause it was carried out to facilitate the process of the JPG creation.

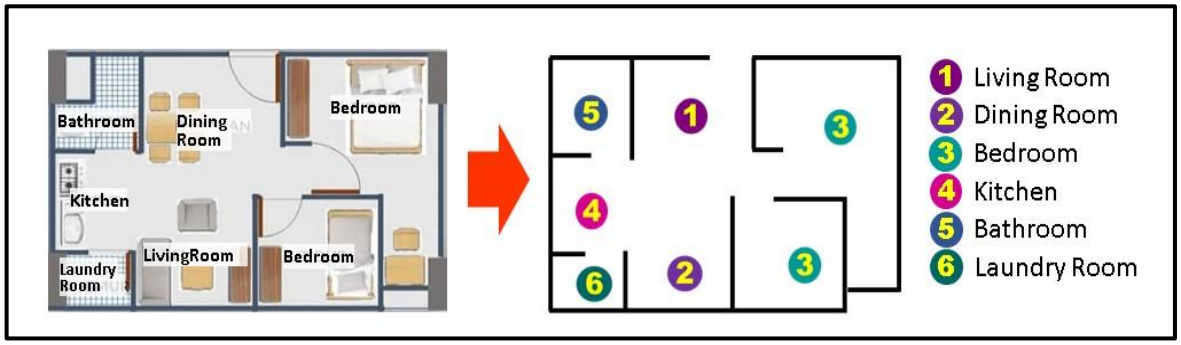

Figure 2. Example of a flat residential unit layout (left) and its redrawn layout (right)
Source: SIRUKIM and Author, 2024

2.3. JPG depiction of each residential unit layout

Based on the redrawn layouts, a JPG is drawn (Figure 3). All of the rooms are connected with thick dotted pink line to describe the connection between the rooms (left side). After that, drawing the JPG by structurized the space organization and giving the mark of them with the *step depth* (right side).

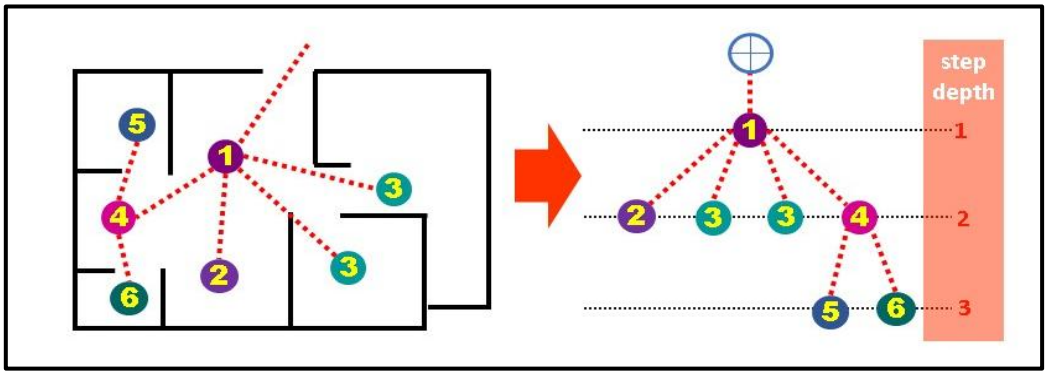

Figure 3. Example of a redrawn residential unit layout (left) and its JPG (right)
Source: Author, 2024

The JPG is drawn to simplify the networks of rooms. The red numbers on the right side shows based on the Figure 3 (right side) the *step depth* of room 1 (living room) is 1. The *step depth* of room 2 (dining room), 3 (bedroom) and 4 (kitchen) are 2. The *step depth* of room 5 (bathroom) and 6 (laundry room) are 3.

2.4. Calculation of integration value

To calculate the *integration value*, there should be known the *step depth* value (the depth level of a space). *Step depth* or total depth can be obtained after the JPG is completed. Next, the mean depth is calculated using the formula [14]:

$$MD = \frac{TD}{L-1} \qquad \text{.....(1)}$$

Source: Siregar, 2014

Where:
MD: Mean Depth L: Sum of rooms in the system
TD: Total Depth

The next, RA (Relative Asymmetry) is calculated to compare the depth of the axial map of a particular room to the depth and shallowness of the room [14].

$$RA = \frac{2(MD - 1)}{L - 2} \quad \text{……..(2)}$$

Source: Siregar, 2014

Where:
RA: Relative Asymmetry L: Sum of rooms in the system
MD: Mean Depth

Next, GL (standardized RA) is calculated using the following formula [14]:

$$GL = \frac{L(\sqrt{L}) - 2L + 1}{(L - 1)(L - 2)} \quad \text{…….(3)}$$

Source: Siregar, 2014

Where:
GL: standardized RA L: Sum of rooms in the system

Next, RRA (integration) is calculated. If the RRA value is low, it means that the integrity value is high in that space configuration [14].

$$RRA = \frac{RA}{GL} \quad \text{…….(4)}$$

Source: Siregar, 2014

Where:
RRA: Real Relative Asymmetry GL: standardized RA
RA: Relative asymmetry

2.5. Graphic comparison of integration values

The *step depth* and number of rooms on each residential unit were calculated. After that, the *integration value* for each room is calculated. Based on this data, the *integration value* line charts on each residential unit are created and superimposed so that it can be examined whether there are sameness patterns.

3. Result and Discussion

Based on the unit layouts obtained, the Justified Plan Graph (JPG) is created and the *integration value* for each room is calculated. The following is layouts, JPGs and table of *integration values* for each room. The lower the *integration value* of the room, the more accessible that room[1][2][3][4] [14][17]. In order to make the assessment easier, the *integration value* is converted to be minus. So that the higher the value of integration score the more accessible and important that room.

3.1. Lokbin Rawa Buaya Subsidized Flat

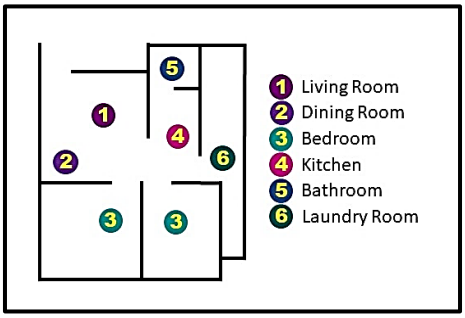

Figure 4. Lokbin Rawa Buaya Flat Residential Unit Layout, West Jakarta
(Source: SIRUKIM, 2024)

The layout of residential units on Lokbin Rawa Buaya Flat from the SIRUKIM (DKI Jakarta Public Housing and Settlement Agency App) [7] is redrawn and each room is numbered (Figure 4). Based on this drawing, every room on the layout is connected with a thick pink dotted line to figure out the connection between the rooms and facilitate the process of Justified Plan Graph (JPG) production (Figure 6).

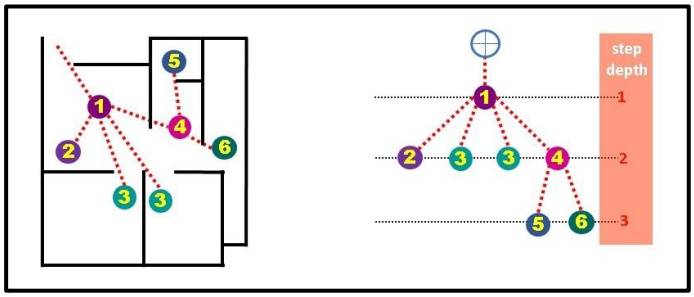

Figure 5. Layout (left) and Justified Plan Graph (right) of Lokbin Rawa Buaya Flat Residential Unit, West Jakarta (Source: Author, 2024)

According to Figure 6, the JPG (right side) is drawn based on the layout of the residential unit (left side). The red numbers on the right side of the JPG show the *step depth* of the related rooms (connected with a thin black dotted line). For example, the *step depth* of room number 2 (dining room), 3 (bedroom) and 4 (kitchen) is 2, the *step depth* of room number 5 (bathroom) and 6 (laundry room) is 3.

Based on the JPG and the *step depth* of each room, the *integration value* is calculated (Table 1) using the formula from Space Syntax which had described before (poin 2.4).

Table 1. *Integration values* on each Room of Lokbin Rawa Buaya Flat Residential Unit, West Jakarta

Rooms	TD (number of *step depth*)	L (number of rooms)	MD or TD / (L-1)	2 X (MD-1)	L-2	RA	√L	L(√L) -2L+1	(L-1) X (L-2)	GL	RRA or Integration	Integration (-)
Living Room	1	7	0,14	-1,71	5	-0,34	2,65	5,52	30	0,18	-1,86	**1,86**
Dining Room	2	7	0,29	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Bedroom 1	2	7	0,29	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Bedroom 2	2	7	0,29	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Kitchen	2	7	0,29	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Bathroom	3	7	0,43	-1,14	5	-0,23	2,65	5,52	30	0,18	-1,24	**1,24**
Laundry Room	3	7	0,43	-1,14	5	-0,23	2,65	5,52	30	0,18	-1,24	**1,24**

Source: Author, 2024

The lower room *integration value*, the higher accessibility and important that room [14]. In order to make the *integration value* easier to be interpreted, they are converted to be positive in Table 1. So that the higher *integration values* in the integration (-) column, the more accessible and important the rooms are.

3.2. Nagrak 6-10 Flat

The methodes which used in the Lokbin Rawa Buaya Flat, applied to the other Flats. So that the *integration values* of each room could be calculated (Figure 6 and 7, Table 2).

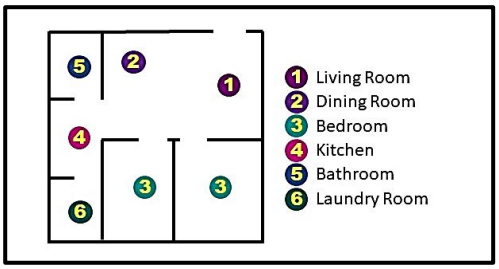

Figure 6. Nagrak 6-10 Flat Residential Unit Layout, West Jakarta (Source: SIRUKIM, 2024)

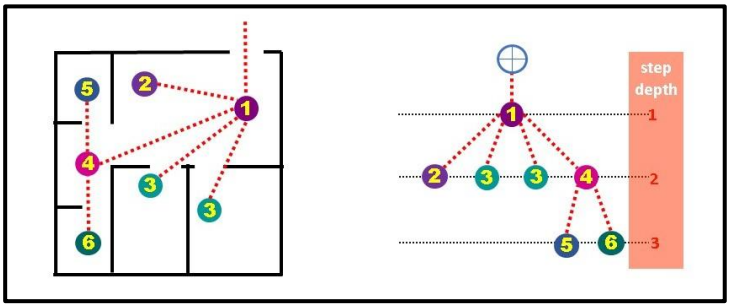

Figure 7. Layout (left) and Justified Plan Graph (right) of Nagrak 6-10 Flat Residential Unit, West Jakarta (Source: Author, 2024)

Table 2. *Integration values* on each Room of Nagrak 6-10 Flat Residential Unit, West Jakarta

Room	TD (number of *step depth*)	L (number of rooms)	MD or TD/(L-1)	2(MD -1)	L-2	RA	√L	L(√L)-2L+1	(L-1) x (L-2)	GL	RRA or Integration	Integration (-)
Living Room	1	7	0,14	-1,71	5	-0,34	2,65	5,52	30	0,18	-1,86	**1,86**
Dining Room	2	7	0,29	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Bedroom 1	2	7	0,29	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Bedroom 2	2	7	0,29	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Kitchen	2	7	0,29	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Bathroom	3	7	0,43	-1,14	5	-0,23	2,65	5,52	30	0,18	-1,24	**1,24**
Laundry Room	3	7	0,43	-1,14	5	-0,23	2,65	5,52	30	0,18	-1,24	**1,24**

Source: Author, 2024

3.3. Padat Karya Flat

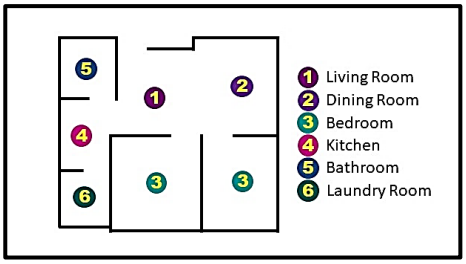

Figure 8. Padat Karya Flat Residential Unit Layout, West Jakarta (Source: SIRUKIM, 2024)

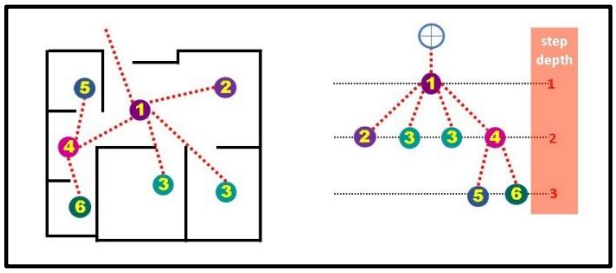

Figure 9. Layout (left) Justified Plan Graph (right) of Padat Karya Flat Residential Unit, West Jakarta (Source: Author, 2024)

Table 3. *Integration values* on each Room of Padat Karya Flat Residential Unit, West Jakarta

Rooms	TD (number of *step depth*)	L (number of rooms)	MD or TD/(L-1)	2(MD-1)	L-2	RA	√L	L(√L)-2L+1	(L-1)(L-2)	GL	RRA or Integration	Integration (-)
Living Room	1	7	0,14	-1,71	5	-0,34	2,65	5,52	30	0,18	-1,86	**1,86**
Dining Room	2	7	0,28	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Bedroom 1	2	7	0,28	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Bedroom 2	2	7	0,28	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Kitchen	2	7	0,28	-1,43	5	-0,29	2,65	5,52	30	0,18	-1,55	**1,55**
Bathroom	3	7	0,42	-1,14	5	-0,23	2,65	5,52	30	0,18	-1,24	**1,24**
Laundry Room	3	7	0,42	-1,14	5	-0,23	2,65	5,52	30	0,18	-1,24	**1,24**

Source: Author, 2024

There are layouts of the Lokbin Rawa Buaya, Nagrak 6-10 and Padat Karya Flats, West Jakarta (Figure 4, 6, 8). The room names are written in numbers to facilitate the JPG creation process. Based on the unit layout,

each room is connected with dotted red lines that indicate its connectivity (Figure 5, 7, 9). Based on these connectivity lines, a JPG image is composed (on their right side). On the right side of the JPGs, there are numbers that indicate the depth (*step depth*) of each room. For example, room no. 4 (Kitchen) is on the dotted line number 2. This means that the *step depth* of the Kitchen is 2, so that to reach the Kitchen we have to pass through 1 previous room, namely the Living Room. Another example, room no. 5 (Bathroom) is on the dotted line number 3. This means that the *step depth* of the Bathroom is 3, so that to reach the Bathroom we have to pass through 2 previous rooms, namely the Living Room and Kitchen. It means the Dining Room is easier to access than the Bathroom.

By using the *integration value* formula and *step depth* data on the JPG above, the *integration value* of each room on the residential unit in the Lokbin Rawa Buaya, Nagrak 6-10 and Padat Karya Flats, West Jakarta can be obtained (Table 1, 2, 3). Based on the *integration value* tables, it can be seen that all the *integration values* are the same. The Living Room has the highest *integration value*, which means it has the highest accessibility value compared with other rooms. On the other hand, the Bathroom and Laundry Room have the lowest *integration value*, which means that these rooms have the lowest accessibility value or are the most difficult to reach.

3.4. Kelapa Gading Timur Flat

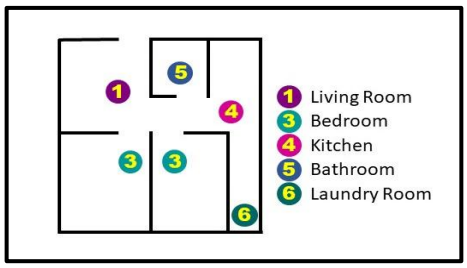

Figure 10. Kelapa Gading Timur Flat Residential Unit Layout, East Jakarta
(Source: SIRUKIM, 2024)

Mentioned above is a residential unit layout of the Kelapa Gading Flat, East Jakarta (Figure 10). There is no dining room. Based on the JPG image (Figure 11), it could be seen that room no. 4 (Kitchen) only has 1 branch (Laundry Room). It is different from the 3 other previous JPGs in which their kitchen has 2 branches (Bathroom and Laundry Room).

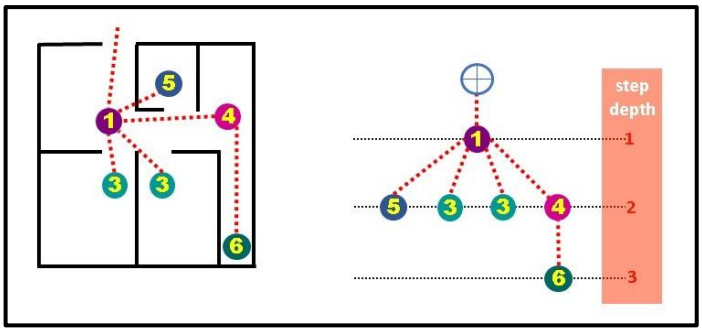

Figure 11. Layout (left) Justified Plan Graph (right) of Kelapa Gading Flat Residential Unit, East Jakarta
(Source: Author, 2024)

Table 4. *Integration value* on each Room of Kelapa Gading Timur Flat Residential Unit, East Jakarta

Rooms	TD (number of *step depth*)	L (number of rooms)	MD or TD/(L-1)	2(MD-1)	L-2	RA	√L	L(√L)-2L+1	(L-1)(L-2)	GL	RRA or Integration	Integration (-)
Living Room	1	6	0,17	-1,67	4	-0,42	2,45	3,70	20	0,18	-2,25	**2,25**
Dining Room												
Bedroom 1	2	6	0,33	-1,33	4	-0,33	2,45	3,70	20	0,18	-1,80	**1,80**
Bedroom 2	2	6	0,33	-1,33	4	-0,33	2,45	3,70	20	0,18	-1,80	**1,80**
Kitchen	2	6	0,33	-1,33	4	-0,33	2,45	3,70	20	0,18	-1,80	**1,80**
Bathroom	2	6	0,33	-1,33	4	-0,33	2,45	3,70	20	0,18	-1,80	**1,80**
Laundry Room	3	6	0,50	-1,00	4	-0,25	2,45	3,70	20	0,18	-1,35	**1,35**

Source: Author, 2024

Based on the *integration value* table (Table 4), it can be seen that the Bathroom has higher *integration value* compared with the one on the 3 other residential units because it has shallower *step depth*.

3.5. Pulo Gadung Phase-1 Flat

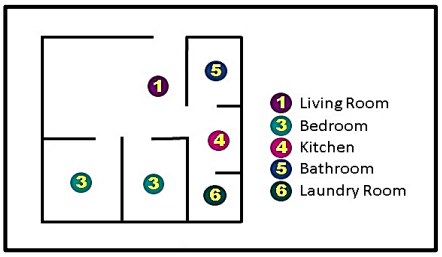

Figure 12. Pulo Gadung Phase-1 Flat Residential Unit Layout, East Jakarta
(Source: SIRUKIM, 2024)

Mentioned above is a layout of the Pulo Gadung Phase-1 Flats, East Jakarta (Figure 12). There is no dining room like 3 other layout units (Lokbin Rawa Buaya, Nagrak 6-10 and Padat Karya Flats), but it has the samenes with them that their kitchen has 2 branches (Bathroom and Laundry Room).

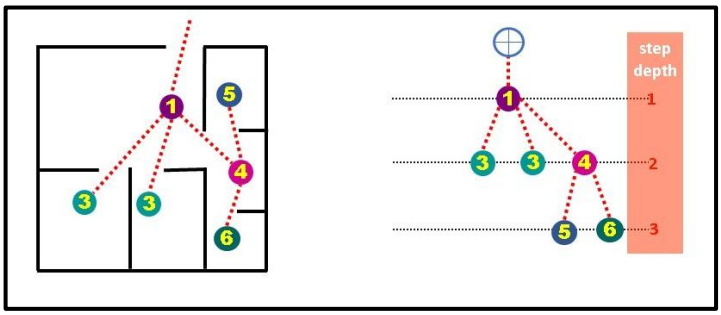

Figure 13. Layout (left) Justified Plan Graph (right) of Pulo Gadung Phase-1Flat Residential Unit, East Jakarta
(Sources: Author, 2024)

Table 5. *Integration value* on each Room of Pulo Gadung Phase-1 Flat Residential Unit, East Jakarta

Rooms	TD (number of *step depth*)	L (number of rooms)	MD or TD/(L-1)	2(MD-1)	L-2	RA	√L	L(√L)-2L+1	(L-1)(L-2)	GL	RRA or Integration	Integration (-)
Living Room	1	6	0,167	-1,667	4	-0,417	2,449	3,697	20	0,185	-2,25	**2,25**
Dining Room												**0,00**
Bedroom 1	2	6	0,333	-1,333	4	-0,333	2,449	3,697	20	0,185	-1,80	**1,80**
Bedroom 2	2	6	0,333	-1,333	4	-0,333	2,449	3,697	20	0,185	-1,80	**1,80**
Kitchen	2	6	0,333	-1,333	4	-0,333	2,449	3,697	20	0,185	-1,80	**1,80**
Bathroom	3	6	0,500	-1,000	4	-0,250	2,449	3,697	20	0,185	-1,35	**1,35**
Laundry Room	3	6	0,500	-1,000	4	-0,250	2,449	3,697	20	0,185	-1,35	**1,35**

(Source: Author, 2024)

Based on the *integration value* table (Table 5), it can be seen that the Bathroom has lower *integration value* compared with the one before but the other hand the Laundry Room has the same *integration value* compare with the one before.

Based on the data processing above, there is the same spatial relationship pattern (JPG) on the 3 types of residential units out of the 5 types of studied residential units, namely the Padat Karya, Nagrak 6-10 and Lokbin Rawa Buaya Flat.

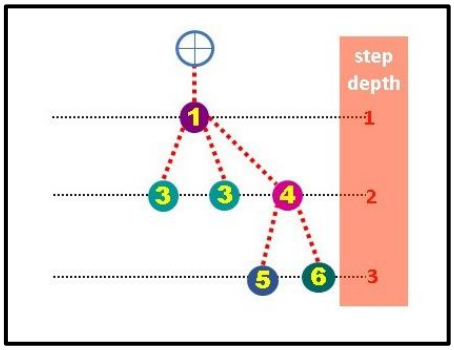

Figure 14. Justified Plan Graph of Padat Karya, Nagrak 6-10 and Lokbin Rawa Buaya Flat
(Sources: Author, 2024)

The JPG (Figure 14) reflects a compact layout with a little *step depth* (high *integration values*) makes it easier for residents to acces all rooms easily. Besides, the living room and dining room are merged so that activities in those spaces can be more flexible. Both of the rooms has shallow *step depth* which makes it easier and more comfortable for guests to access. This also means that residents respect guests, so accessibility is made as comfortable as possible. Another findings is that the kitchen which has branches to the bathroom and laundry room shows that activities carried out in the kitchen can be carried out simultaneously with other activities in the bathroom and laundry room (for example while cooking, bathing children, or washing and ironing clothes)

The following is a comparison diagram of the *integration values* graphic on each room of each studied residential unit type:

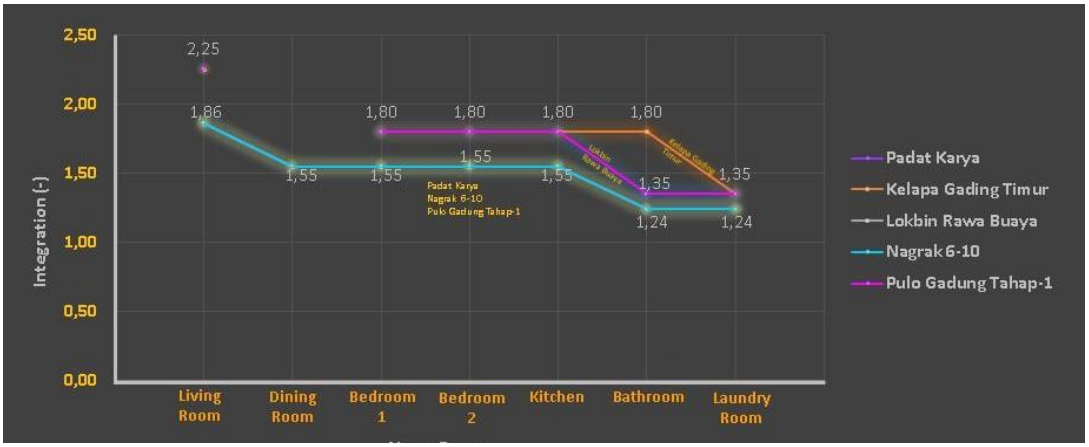

Figure 15. Comparison diagram of *integration value* line graphic on each room of each flat residential unit type
(Source: Author, 2024)

Based on the diagram above (Figure 15), it is known that the Living Room has the highest *integration value* of all unit types of Flats. The *integration value* line graph of the Padat Karya, Rawa Buaya Lokbin and Nagrak 6-10 Flats residential unit types are on the same line because they have the same *integration value*. Meanwhile, there is the same *integration value* on the Living Room of the Kelapa Gading Timur and Pulo Gadung Phase-1 Flats unit types. The line graph is disconnected at the Dining Room (because there is none).

The diagram tells that all of the 5 residential unit layout have both living room and dining room as the main space and the rooms are considered as a more public room. On the other side, the bathroom and laundry room have deep *step depth*, indicating that these rooms need the highest level of privacy.

4. Conclusion

Based on the comparison of JPGs, *integration values* and the *integration values* graph above, it is concluded that: There are 3 residential unit types that have the same JPG, namely the Padat Karya, Nagrak 6-10 and Lokbin Rawa Buaya Flat. Meanwhile, the other 2 flats, namely Pulo Gadung Flats Phase-1 and Kelapa Gading Timur, have different JPGs.

Those happened because there were similarities between the task provider (DKI Jakarta Public Housing and Settlement Agency) and the architects interpreting the cultural values, the way of life and the way of settle of the DKI Jakarta City residents which resulted in the sameness of 3 JPG residential units, such as a busy life which needs a compact layout with a little *step depth* (high *integration values*) to makes it easier for residents to acces all rooms and being multitasking easily.

Another conclusion is the finding is not enough to determine that the JPG is a genotype, because there are 10 other types of residential unit plans that have not been studied. While the residential unit plans studied were only 5. So the JPG are not representative of the 15 types of residential unit plans which are located throughout DKI Jakarta.

Based on the conclusions, it is recommended that there is a need for further JPG research regarding the all other 36m^2 residential unit type on subsidized flats in DKI Jakarta so that the stronger genotypes can be identified. Besides, it is also necessary to conduct further research regarding the culture and lifestyle of DKI Jakarta residents which are the basis for the task providers and architects in designing residential unit so that the better genotypes could be created. Another recommendation is there should be feedback from the resident, whether they can live in the existing residential unit conveniently or not to make the new and better JPG genotype. Based on the new and better JPG, the architects who design the future subsidized flats could be helped in designing the new and better residential unit layouts. If the JPG finding research is succeed, there might be some other similar JPG research related to other region in Indonesia. So that the assigned architects could make a residential unit layout which could accomodate the users needs more effectively on future.

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6. Conflict of Interest

The authors certify that the publication of this research study does not involve any conflict of interest.

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