Environmental behavior analysis of social housing units in Surabaya, Indonesia

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1. Introduction

Social housing has been discussed around the world and defined in several ways. According to the Aedes code for the Dutch housing associations, the primary goals of social housing are to provide good housing for low-income, elderly, disabled, disadvantaged, and homeless people who want to have a place for a better life (Priemus 2013). Based on this description, to provide good housing means to create a comfortable place to live properly. In Surabaya, The Laboratory of Housing and Human Settlements of the Institute Teknologi Sepuluh Nopember conducted research and identified social housing in Surabaya. The report concluded two important points: 1) the construction of social housing and the infrastructure, facilities and public utilities; 2) housing quality improvement. One of the requirements to construct social housing is the compatibility between the infrastructure, facilities and public utility service capacity and the number of housing units as well as the number of inhabitants. In this regard, the government should provide compatibility between the number of units and the number of occupants who live in it. However, there are many violations that occur regarding the number of occupants who live in the unit of social housing. Therefore, it is necessary to evaluate the availability of space and the number of occupants in order to determine adequately off the unit in accommodating the daily activities of occupants.

Social housing in Surabaya has become a major concern due to urbanization and the rapid growth in population. The previous study for 14 social housing locations in Surabaya recommended discontinuing the 18 sqm unit size for social housing (Kisnarini, Van Egmond, and Mohammadi 2012). The study concluded that the 18 sqm unit size was inadequate, gave off a slum impression, and occupied public spaces around the building; especially when the unit occupied by more than 4 family members. It is important to note that the study analyzed in general without taking into consideration the certain floor area with all the spatial adjustment they had made. Subsequently, the analysis of space usage for 14 social housing locations did not mention the time and duration of every activity which was carried out in the unit on a typical day.

After suggesting that 18 sqm to be discontinued, the study stated that the local government keeps enlarging the unit size to become 21 sqm, 24 sqm, and 32 sqm. The data of social housing in Surabaya are listed in Table 1. However, to keep enlarging the unit size does not overcome the problems such as being inhumane, giving a slum impression, and occupying public spaces around the building; it is because the needs of occupants always develop according to the time, for example, the member of the family grown, new lifestyle due to the technological advance, or a new family type (Till and Schneider 2016).

This study was conducted at Dupak Bangunrejo’s social housing which was built in 1985. This complex of
The analysis was carried out in three parts: firstly, to observe the process of occupant’s effort for space requirement for service activities; secondly, to record the occupant’s area requirements and room functions based on variety and frequency of activity in the unit; thirdly, to demonstrate how the occupant utilizes the adjustment and the highly needed rooms based on furniture configurations in the public area.

2. Literature review

As the second largest city in a developing country, the population in Surabaya increases every year. In the year of 2012, the population of Surabaya is 3,110,187 inhabitants (https://surabaya.go.id/). The study about low-cost apartments in Surabaya stated that Surabaya has a higher population density as 8,459 people/km2 compared to other districts in East Java. In addition, the study also stated that until 2012, the housing backlog in Surabaya is 600,000 units. The government only provides 60,000–70,000 units per year (Rachmawati et al. 2015). Therefore, the local government builds social housing to overcome urban problems. The first social housing was built in 1985 in Surabaya (Silas 1990). The unit size was built based on the major need for space for low-income households which was 18 sqm. The building of social housing completed with all the facilities has been still actively used until recent days. However, due to the need for spaces, every unit has changed. The changes were done by occupying public paths, carrying out activities in public spaces around the building, and occupying public aisle for service activities. A previous study for social housing in Surabaya concluded these conditions were also triggered by the number of the family which is more than 4 members (Kisnarini, Van Egmond, and Mohammadi 2012). Consequently, the research recommended discontinuing the 18 sqm unit size to be built for social housing. This decision led to the question: what exactly happened in a unit size of 18 sqm?, especially after the unit extended for kitchen and

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Table 1. The social housing in Surabaya (source: The Laboratory of Housing And Human Settlement, Institut Teknologi Sepuluh Nopember (ITS), Surabaya, 2015).

| Name of SH | Year of built | Size of unit (sqm) | Type of services | Type of unit |
|------------|---------------|-------------------|-----------------|-------------|
| Dupak Bangunrejo | 1989/1990 | 18 | Private/communal | Open plan |
| Sombo | 1989/1990 | 18 | Communal | Open plan |
| Warugunung | 1996 | 21 | Private | Open plan |
| Penjaringansari I | 1998 | 18 | Communal | Open plan |
| Penjaringansari II | 2004 | 21 | Private | Open plan |
| Penjaringansari III | 2009 | 24 | Private | Fix partition |
| Urip Sumoharjo | 2004 | 21 | Private | Open plan |
| Randu | 2007 | 21 | Private | Open plan |
| Wonorejo | 2002/2008 | 21 | Private | Open plan |
| Tanah Merah | 2007/2009 | 21 | Private | Open plan |
| Grudo | 2011 | 24 | Private | Fix partition |
| Pesapen | 2011 | 24 | - | - |
| Jambangan | 2011 | 24 | - | - |
| Siwalankerto | 2012 | 24 | - | - |
| Romokalisari | 2012/2013 | 24 | Private | Fix partition |

Abbreviation: SH: social housing; sqm: square meters.

Social housing was built in four different phases. The study was conducted at the first phase which contained two separate buildings, namely, block A and block B. Each building has three floors. On the first floor, there are nine units, and on the second and third floors, there are eight units. The first floor of the building provides a communal kitchen and private shower area for every unit. On the second and third floors, the units have communal shower and kitchen areas. The unit size of Dupak Bangunrejo’s social housing is 18 sqm. Interestingly, every unit on the first floor occupies a public path to become a small private kitchen. By having a private kitchen, the communal kitchen does not function anymore and some occupants use it for a storage area. Furthermore, by the time, the occupants have occupied the public aisle behind the private kitchen to become laundry and dishwashing area.

However, the unit that has been extended by occupying the public pathway does not seem to be able to fully overcome the problem of occupants to meet the space requirements in the unit. This can be seen by the use of other public spaces around the building such as hallways and side pathways for some activities carried out by occupants such as playing, relaxing, caring children, and even selling local foods. These activities increasingly give the impression of social housing becoming more slummy and inhumane. Based on the fact and condition mentioned above, the following research questions were developed:

(1) What is the occupant’s effort to fulfill service activities in the unit?
(2) What are the occupant’s area requirements and room functions in the unit?
(3) What are the occupant adjustment and the highly needed rooms based on furniture configuration in the public area?

A qualitative descriptive method is used in this study and the data were collected through observation, demonstration, photographs, and informal interviews.
laundry-dishwashing area. Furthermore, the study for the importance of functionality in realizing sustainability for 14 social housings in Surabaya concluded a multifunction zone located in between “more public sub-zone” and “more private sub-zone”. The more public sub-zone was comparable to living room (Kisnarini, Van Egmond, and Mohammadi 2012). This means a multifunction zone which accommodates diverse activities locates in between two zones, whilst “more public sub-zone” similar to living room. This finding argues the study for “living room” which stated that living room accommodates various functions for many activities (Amaturo, Costagliola, and Ragone 1987; Mitton and Nystuen 2016; Rechavi 2009) in (Saruwono, Zulkiflin, and Mohammad 2012). In addition, the study about the functions of a living room stated that the location of the living room is in the first space to enter a house (Rechavi 2009; Saruwono, Zulkiflin, and Mohammad 2012). Thus, living room is the first entering area in a house which accommodates various activities. Therefore, further research is needed in space design analysis in a small unit of social housing. Hence, what is actually space?

According to Tuan, space is explained as a location and has no social connections for a person. Space is open and does not mean to drive a human being to fill or do something in it (Tuan 2011). This statement argues to the fact of occupant’s behavior in a small unit of social housing in Surabaya. Due to the lack of space availability in the unit, the occupants occupied other spaces to carry out their activities. In addition, research related to space states that space is formed based on the needs of occupants who have a time limit. This study emphasizes that space cannot be discussed without taking into account the temporal pattern based on the time used, such as duration, daily rhythm, and so on (Zhang, Liu, and Wang 2018). In this regard, there is an activity that has time or period in it. Thus, there is a strong relationship between space, activity and time. Based on the statement, the activity can be measured by the duration of activity. In other words, there is a beginning time and will end at a certain time; both points are significant to cognition the duration of an activity and the temporal pattern of a set of activities. Accordingly, to understand the various daily activities in the unit, space and time are important to be concerned. All activities can be calculated and determined for how long it lasts. This statement was established by the study for functionality and adaptability for social housing that concluded the relation between space and activity. Moreover, it was explained that space design was obtained based on occupant activities which were affected by occupants’ characteristics (Kisnarini 2015). Thus, referring to the conclusion from the previous study, the space design of houses defines as the results of the analysis process between space and occupancy needs of occupants (Kisnarini 2015). The study stated that the unit should provide the space properly for the occupants to carry out their activities in order to meet their needs. However, the study did not specify the future need for occupants. Today, in the developing era of technology, people change their lifestyle rapidly. Therefore, the design of the unit should focus on the development of the future needs of occupants. In this regard, the unit should be able to adjust to the changing needs of users (Till and Schneider 2016). In other words, the unit has to be flexible due to the variety of occupant’s needs which change rapidly.

In the design field, flexibility has long been discussed especially for housing space. In general, flexibility is defined as the capability of space to adaptively or structurally adjusting to constant changes in users, including social, sustainability, and economic issues (Ritter, Paris, and Lopes 2018). The words of “constant changes in users” establish the definite changes made by occupants every time. Thus, flexible housing is able to be adjusted to the needs of occupants. Therefore, flexible housing, as explained further, is the housing that is able to be adjusted to the changing needs and patterns, for social and technological issues (Till and Schneider 2016). Furthermore, the term flexible housing for developing countries such as Indonesia was investigated in Bangladesh. The finding in the study stated that the concept of flexibility in buildings gives some advantages in developing countries because it increases the building’s lifespan and avoids demolition (Kumar Dhar, Maruf Hossain, and Rubayet Rahaman 2013). This statement was emphasized to the long term of use of the building, due to the limited funds owned by the government. This concern was intended to prevent the demolition of a social housing building. Hence, rather than incurring a cost for construction and at a certain time to dismantle it, it is better to build social housing that can be used for a relatively long time. Moreover, it was concluded that people at the middle and lower-income levels often made changes to their place of residence. They make changes every 5–10 years. These changes were made based on the rent market issue, changes in lifestyle and family structure, and technology. Similar problems happen in most of the occupants in social housing in Surabaya. The changes in lifestyle encourage other changes in the order of social and economic life.

3. Methodology

The Dupak Bangunrejo, the oldest social housing in Surabaya, was selected as a case study due to the original unit size which is 18 sqm and the extended space to meet the space requirement of occupants. One of the units was chosen on the first floor due to the occupant’s space usage problems; the unit was gradually extended and it occupied public spaces around the building.
3.1. The unit information

The original unit size was 3 m x 6 m = 18 sqm with a shower room in the unit. The location of the unit is Block B-1, no. 16. This original unit is on the first floor and facilitated by the communal kitchen area. The unit was built by brick wall, wood frame and wood door. This typical unit was designed based on an open plan or without any partition and has a 3.05 m ceiling height. The plan and section A-A of the original unit size of Block B-1, no. 16, are illustrated in Figure 1.

3.2. The household information

Name of the occupant (family): Gatot family (second generation) and Wakir family (first generation). The family has six members. The data of the family are listed in Table 2. The interior pictures of unit Blok B-1, no. 16, are captured in Figure 2.

3.3. Data collection and analysis method

The basic method of this study is qualitative descriptive. The data were collected through observation, demonstration, photographs, and informal interviews. The research was started by conducting an observation for the whole fieldwork area which consists of nine units on the first floor (and two buildings at the first phase construction) to find out the unit cases which were resided by the household’s family. One unit case in which the area is 18 sqm to 28.95 sqm was selected to describe the space requirement and space usage in the unit.

The analysis was carried out in three parts: firstly, to observe, have informal interviews, and analyze the process of occupant’s effort for space requirements in the unit, especially to provide service areas such as kitchen and laundry-dishwashing areas. Secondly, to record by taking photographs, having a demonstration and informal interviews, and then analyzing the occupant’s space requirement for area requirements and room functions based on the variety and frequency of activities in the unit for 24 hours. Thirdly, to illustrate, having demonstration, observation, have informal interviews, and analyze the way occupants utilize the occupant adjustment and furniture configurations based on their activities in the public area. The data collection and analysis method is explained in Table 3. The process of data collection and analysis method is illustrated in Figure 3.

4. Results

The result of the analysis has been divided into three sections and focuses on three following points: firstly, the occupant’s effort for service activity. This section lists, illustrates and describes the process of unit extended for service area to accommodate service activities in the unit. The second point is the occupant’s space requirement (arrangement) in the unit. The second part is recording, listing, illustrating and describing the area requirements and room functions based on various and frequency of daily activity, and it is divided into day-night period. The last point is the way the occupant utilizes the occupant adjustment and furniture configuration in the public area. This segment lists, illustrates, and describes the occupant adjustment by furniture configuration for day-night period in the public area.
4.1. The occupant’s effort for service activities

Based on the informal interview with the occupants, the communal kitchen does not provide privacy and triggers many social issues between occupants. Thus, since the area is required for daily activities in the unit, the occupants extend the original unit size. The first extension was done for the kitchen and occupied the public pathway behind the building as 2.15 meters wide, Figure 4(a). The second extension was for the laundry-dishwashing area and occupied the public aisle as 1.5-m wide, Figure 4(b). This service area was built in a very modest design, using an affordable and simple material. Therefore, the design and utility systems were made in a simple design and simple way to adapt to the existing conditions of the building. However, these new facilities in the unit also give problems such as lack of air circulation, inadequate daylight/light, improper utility systems, and direct drainage to the city channels. The total size of unit extended is listed in Table 4. The total size of the unit extended is illustrated in Figure 5.

An initial overview based on the occupant’s behavior to extend the unit size reveals that the 18 sqm unit size does not accommodate the space required for daily activity in the unit, in particular the service activities. Based on the on-site observation and a direct interview with the occupants, although social housing provides a communal kitchen for occupants, it does not fulfill their requirements. The occupants prefer to build a private kitchen even though it was built and occupied a public pathway. Furthermore, the occupants also occupied public aisle to construct laundry and dishwashing room. However, these two rooms were built without official permission from the regional government and without proper supervision. The two rooms were constructed in a very simple design without an adequate utility system. Nevertheless, a private kitchen and laundry-dishwashing room are very convenient to be located in the unit. This private kitchen and laundry-dishwashing room make the occupants easier and convenient to operate household activities.

4.2. The area requirements and room functions in the unit

The area requirements in the unit was adjusted by dividing the open plan to provide smaller areas followed by three different spatial utilization patterns. The three areas are public, private, and service. The public area was utilized to accommodate activities such as watching tv, playing, caring children, working, and relaxing. This area was provided with loose furniture to accommodate the activities; the public area is illustrated in Figure 6(a). There is only a thin curtain (vitrage) as a divider between public and private areas. The private area was provided to accommodate activity that requires privacy, such as praying, dressing, sleeping, and relaxing. In the private area, there is one wooden bunkbed without enough space left, only for circulation through from public to service
area. The wooden bunk bed is fixed furniture which is placed against two walls, Figure 6(b). In between private and service areas, there is a brick wall as a divider and as a wall for shower room. The service area has a shower, kitchen and laundry-dishwashing space to accommodate service activities such as shower, cooking, laundry, and dishwashing. The kitchen has a modest fixed table work and much equipment whilst the laundry-dishwashing area has kitchen sink and equipment with hanging clothes dryer, Figure 6(c). The area requirements in the unit are drawn in Figure 7.

4.2.1. Daily activity analysis of the subject household

The method of analysis was used is based on counting the occupant’s activity combined with time differentiated in day and night period for 24 hours. The calculation was done in order to obtain data about the frequency and duration of activity in each area. The frequency and duration determine the type of room to accommodate the number, type, and duration of activities. Thus, the results of the analysis obtained room function requirements, a number of room functions, and the types of activities that are mostly carried out in a particular area.

During the daytime, the daily activities start from 04:31 am to 16:30 pm (for 12 hours). The public area has room functions as bedroom, living, dining and service rooms for 10 activities for 10 hours. At the same time, the private area has room functions as living and praying rooms, and bedroom for six activities in 5.5 hours. Meanwhile, the service area has room functions as a shower, kitchen, and laundry-dishwashing rooms for 12 activities in 9 hours. Thus, in the day period, the public area has more room functions and service area has more activities. The more room functions in the public area are caused by more space and loose furniture. Meanwhile, more activities in service area are caused by many short-duration activities, such as shower. Thus, the more functions in the public area which should be done in private and service area indicate that occupants prefer to do activities in the public area. It causes the public area to have more duration compared to the two areas. The area requirements and room functions in the day period are listed in Table 5.

On the other hand, the night period starts from 16:31 pm to 04:30 am (for 12 hours).

The public area has room functions as bedroom, and living, study, dining and service rooms for 12 activities in 21.5 hours. Meanwhile, the private area has room functions as living and praying rooms, and bedroom for 5 activities in 10.5 hours, whereas the service area has room functions as kitchen, shower, and laundry-dishwashing rooms for 7 activities in 4 hours. Hence, in the night period, the public area has more room functions and most activities compared to the two areas. At this time, the occupants have many entertaining

| Data collection method | Result |
|------------------------|--------|
| First data collection | Service requirements, room functions, multi-functions area. |
| Second data collection | Unit extension (18 sqm). |
| Third data collection | Unit extension (9 sqm). |

*Table 3: The data collection and analysis method.*
activities. It shows the occupants prefer to do these activities in the public area which has more space and loose furniture. Thus, in the night period, the public area has more room functions, activities and duration compared to the two other areas. The area requirements and room functions in the night period are listed in Table 6.

A further observation based on the occupant’s behavior for space area requirement resulted the open plan unit was divided into three different areas as public, private and service areas. Every area has different room functions to accommodate the daily activity. Furthermore, based on the two tables above, there are five room functions for the public area, three room functions for the private area, three room functions for the service area. In addition, there are 35 activities in 28.5 hours for the day period; and 27 activities in 37.5 hours for the night period. This number explained the occupant’s behavior generates public area as the multi-function area. Referring to the number of activities and the duration, the day period has many short-duration activities. Conversely, the night period needs more duration. This was shown based on fewer activities but longer duration. Moreover, there are several activities carried out simultaneously in one area or in a different area. This

| Name                | The extend unit size | User   |
|---------------------|----------------------|--------|
| Unit                | 3 m × 6 m = 18 sqm   | 6 persons |
| Extend 1 (kitchen)  | 3 m × 2.15 m = 6.45 sqm | 6 persons |
| Extend 2 (laundry-dishwashing) | 3 m × 1.5 m = 4.5 sqm | 4 persons |
| Total unit size     | 28.95 sqm            | -      |

Figure 3. The process of data collection and analysis method in the unit.

Figure 4. (a) The first extension for kitchen (occupied public pathway). (b) The second extension for laundry-dishwashing (occupied public aisle).
caused the total of using the time to become more than 24 hours. The summary of the area requirements and room functions in 24 hours is concluded in Table 7. In addition, there are many private activities which were done in the public area. This indicates the occupants tolerate their privacy and do the activities in the public area. This also proves that the unit is lack of privacy. The summary of activities in the public area is listed in Table 8.
### Table 5. The area requirements and room functions in the day period.

| Period          | Time          | Public Area | Private Area | Service Area | Clup | Total |
|-----------------|---------------|-------------|--------------|--------------|------|-------|
|                 |               | LR | BR | DR | SR | LR | PR | BR | SR | Kit | Lau |      |      |
| Day period      |               |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-07:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-08:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-09:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-09:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-10:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-10:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-11:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-11:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-12:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-12:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-13:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-13:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-14:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-14:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-15:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-15:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-16:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 08-31-16:30   |    |    |    |    |    |    |    |    |     |     |      |      |

**Total hour:** 10 hours 5.5 hours 4 hours 1.5 hours 8.5 hours

**Total activity:** 10 activities 6 activities 15 activities 6 acts. 35 acts.

LR: living room; BR: bedroom; DR: dining room; SR: service room; PR: praying room; SH: shower room; Kit: kitchen; Lau: laundry and dishwashing room; Clup: cleaning up; WTV: watching TV; REL: relaxing; CC: caring children; ST: storing; DRS: dressing; BRK: breakfast; WRK: working; REL: relaxing; PRY: praying; SW: shower; WDH: wudu; CB: cooking breakfast; DW: dishwashing; LD: laundry; LDR: laundry drying.

### 4.3. The occupant adjustment and highly needed room

Due to space availability and loose furniture in the three areas, most of the activities which need furniture configuration were done in the public area. The loose furniture used in the public area is listed in Table 9. The public area was occupied for various and many daily activities. Even some activities that should be done in the private or service area were done in the public area. Thus, all activities done in the public area need furniture configuration. The occupant adjustment in the unit for the public area is drawn in Figure 8.

### Table 6. The area requirements and room functions in the night period.

| Period          | Time          | Public Area | Private Area | Service Area | Clup | Total |
|-----------------|---------------|-------------|--------------|--------------|------|-------|
|                 |               | LR | BR | SR | DR | SR | BR | PR | SR | Kit | Lau |      |      |
| Night period    |               |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-17:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-17:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-18:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-18:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-19:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-19:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-20:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-20:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-21:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-21:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-22:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-22:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-23:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-23:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-30-24:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-01:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-01:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-02:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-02:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-03:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-03:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-04:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-04:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-05:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-05:30   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-06:00   |    |    |    |    |    |    |    |    |     |     |      |      |
|                 | 23-31-06:30   |    |    |    |    |    |    |    |    |     |     |      |      |

**Total hour:** 12 hours 5 hours 7 hours 3 acts. 27 acts.
Table 7. The summary of area requirements and room functions in 24 hours.

| Period                  | Time       | LR | BR | Str | Dr | Sr | LR | Pr | Br | Shr | Kit | Lau | ClUp | Total |
|-------------------------|------------|----|----|-----|----|----|----|----|----|-----|-----|-----|------|-------|
| The daytime period      | 04:31 am to 16:30 pm | 10 | 5.5 | 9   | 3  |     | 10 | 6  |    |     |     |     |      | 27.5  |
| The nighttime period    | 16:31 pm to 04:30 am | 12 | 5   |    | 7  | 3  | 16 |    |    |     |     |     |      | 27    |
| Total                   |            | 22 | 11  |    | 13 | 4.5| 20 |    |    |     |     |     |      | 62    |

LR: living room; BR: bedroom; Str: study room; Dr: dining room; Sr: service room; Pr: praying room; Shr: shower room; Kit: kitchen; Lau: laundry and dishwashing room; ClUp: cleaning-up.

Table 8. The summary of activities in the public area.

| Period   | Room function | The activities in public area | Area should be | Type of activity |
|----------|---------------|--------------------------------|----------------|-----------------|
| Daytime  | Living room   | Watching tv, playing, caring children, storing | Public area     | Public          |
| Bedroom  | Dressing      | Private area                   | Private area    | Private         |
| Dining room | Breakfast; lunch |                     | Dining area    | Private         |
| Service room | Working; ironing |                                | Service area    | Service         |
| Nighttime | Living room   | Watching tv, relaxing, playing, caring children, storing | Public area     | Public          |
| Bedroom  | Sleeping      | Private area                   | Private area    | Private         |
| Study room | Study, storing |                                 | Study area      | Private         |
| Dining room | Dinner       | Service area                   | Service area    | Service         |
| Service room | Working    |                                 |                |                 |

Table 9. The loose furnishings are used in the public area.

| Item             | Quantity |
|------------------|----------|
| Single chair     | 1        |
| Wooden bench     | 1        |
| Stool            | 1        |
| Desk for TV      | 1        |
| Desk for aquarium| 1        |
| Mattress         | 1        |
| Small carpet     | 1        |
| **Total**        | **7 items** |

Based on the occupant's effort to utilize their activities in the daytime, the public area has eight furniture configurations. Most of the configurations represent one activity. Only one configuration to accommodate three activities, namely, watching tv, playing and caring children. Some activities which should be done in private and service areas such as dressing, breakfast, lunch, working, and ironing were done in a public area. Thus, although the unit has been extended, it does not provide spaces for those activities. The furniture configuration in the public area for the day period is illustrated in Figures 9 and 10.

A similar number of configurations were done based on the occupant's effort to utilize activities in the public area for the night period. There are activities carried out simultaneously and caused a long duration of use in the public area. Sleeping, an important activity which should be done in the private area, was carried out in the public area. This happens since the private area does not accommodate enough space for all family members for sleeping activity. Therefore, the public area is the only choice since the public area has more space and a simple mattress that is able to use at any time for sleeping activity. The furniture configuration in the public area for the night period is illustrated in Figures 11 and 12.

The occupant adjustment and furniture configuration reveal the number configuration for the day and night period as eight configurations. Thus, the total

![Figure 8](image-url)
configuration is sixteen different configurations in 24 hours. The eight configurations in the day period represent ten activities in 10.5 hours. On the other hand, another eight configurations in the night period reflect twelve activities in 21.5 hours. This number explained that the occupant adjustment reflected by the furniture configuration showed that in order to meet their space need, the occupants have to make a configuration change in 16 times in public area within 24 hours. This means comparing to the private and service areas, the public area has to accommodate many activities. In other words, there is an imbalance space usage within the unit which occurs in the public area. Furthermore, every configuration should be considered to have their own room. For instance, watching tv, playing, relaxing, and caring children should be done in a living room. Meanwhile, breakfast, lunch, and dinner should be done in a dining room; sleeping should be done in the bedroom; and working and ironing should be done in the service room. Hence, despite having a private shower, kitchen and laundry room, a social housing unit should provide the four main space functions such as living room, bedroom, dining room, and service room (Table 10).

4.4. Discussions

The occupants’ behavior occupying the public path as a private kitchen, as well as the public aisle for laundry-dishwashing area, proves that the 18 sqm unit size does not accommodate the daily activity. At the same time, this evidence proves the tendency of occupants to occupy public space around the building in order to meet the space requirement. This finding confirmed the conclusion of the research for 14 social housing areas in Surabaya (Kisnarini 2015). It was stated in the review, the service areas such as shower/bathrooms, kitchens have to be in the direct supervision of the user. In this regard, the occupants feel more comfortable to have the service areas privately (Habraken 2008). However, these two extensions were done without a proper design and utility system. In other words, the extensions were done without any control from the local government and outright against the local government regulation. These findings also prove and confirm a previous research on social housing in Indonesia (Warouw, Kobayashi, and Jung 2010). The plumbing and wiring system does not build in a proper way and the sewages go into the city channel.

Figure 9. The furniture configuration in the day period (D.a., D.b., D.c., and D.d.).
directly. This gives problems with environmental pollution. Therefore, a certain system is needed in case of maintenance and repair of the unit or building so that it does not interfere in the daily activities of occupants. This has been done in several social housing units by determining wet zones and vertical shafts (Kendall and Teicher 2010).

The area found the open plan unit was divided into three different areas, namely, public, private and service. These areas have a different function to accommodate daily activities. However, based on the space analysis the public area has more functions than the private and service areas. In other words, the public area is a multi-function area (space) in the unit. This finding argues the previous finding for social housing which stated multi-function space is located in the middle of the unit or between the living room and bedroom (Kisnarini, Van Egmond, and Mohammadi 2012). Furthermore, the analysis found that many activities were held in the public area indicates the need for various room functions. There are many private activities which should be done in an area that has privacy, is done in the public area. This finding is further confirmed, without massive partitions between public and private area, the private area does not accommodate properly the private activities, especially for sleeping. The less number of activities in the private area shows that occupants tolerate their privacy to
carry out in the public area. This finding established a study for a lack of private room and the occupants occupy the living room to carry out the private activity (Rechavi 2009). As a Muslim family, this condition should be a concern. The design of the house has to meet the safety of the family by dividing the private life from public associations (Memarian and Ranjbar-Kermani 2011; Othman, Aird, and Buys 2015). Therefore, flexible infill which flexible to meet the needs of occupants and considers the lack of privacy in the unit is needed, especially for flexible partition. A flexible partition creates privacy and has to be easily adaptable to the changes in space. In particular changes the addition of space for future needs. Furthermore, the flexible partition has to be easy to redesign and reconstruct at any time.

Based on the occupant adjustment and activity carried out in the public area, it can be concluded that the public area is the living room in the unit (Saruwono, Zulkiflin, and Mohammad 2012). In addition, referring to the location of the public area in the unit, this finding also confirmed the study about the functions of a living room which stated that the living room is the first place to enter a house (Rechavi 2009). Thus, like the living room, the furniture configuration depends on various features and factors. This finding confirmed the conclusion that the furniture configuration was done to acknowledge the environment and people’s behavior, lifestyle and psychology which encourage them to show their culture (Saruwono, Zulkiflin, and Mohammad 2012).

Furthermore, many activities that were carried out in the public area indicate the imbalance of space usage. This imbalance of space usage in the public area caused inadequate, inhumane, and slummy impressions, especially when the unit was occupied by more than 4 family members. This finding confirmed the previous study of social housing in Surabaya (Kisnarini, Van Egmond, and Mohammad 2012). Consequently, this also indicates that the unit was designed without considering the future needs of occupants. The furniture configurations in the public area represent activities in the unit that are not

Figure 11. The furniture configuration in the night period (N.a., N.b., N.c., and N.d.).
properly accommodated, such as living room, bedroom, dining room, study room, and service room. These findings reveal the priority spaces that are highly needed in the unit concern to purpose, equipment needs, and the character of space (Siła-Nowicka et al. 2016). Therefore, in a unit of social housing, the occupants’ need for spaces should be discussed at the beginning of the design process (Jia 1995). This design process is to avoid the lack of space and also to overcome the future space requirements in the unit.

5. Conclusion

The study found out based on the space requirement especially for service activities, the very limited unit was extended to occupy part of the building although

Table 10. The highly needed rooms in a unit of social housing.

| Period     | Activity in public area     | Highly needed room |
|------------|----------------------------|--------------------|
| Daytime    | Watching tv, playing, caring children, storing | Living room |
|            | Dressing                    | Bedroom            |
|            | Breakfast; lunch            | Dining room        |
|            | Working; ironing            | Service room       |
| Nighttime  | Watching tv, relaxing, playing, caring children, storage | Living room |
|            | Sleeping                    | Bedroom            |
|            | Study, storing              | Study room         |
|            | Dinner                      | Dining room        |
|            | Working                     | Service room       |

Figure 12. The furniture configuration in the night period (N.e., N.f., N.g., and N.h.).
it was against the local government regulations. The new size encourages the occupants to accommodate the daily activity more manageable. The unit was arranged into area requirements, room functions, occupant adjustment, and furniture configurations. Nevertheless, the space requirement of occupants develops over time and exceeds the ability of the unit to accommodate the space need. The area requirements and room functions in the unit reveal the public area was occupied by five different room functions. This indicates for this type of unit and size, the public area is the multi-function area (space). The multi-function area means the imbalance use and the lack of privacy in the unit. In addition, the lack of privacy to carry out activities in the unit occurs because there is not massive divider between public and private areas. Moreover, the furniture configurations establish the highly needed room in the social housing unit such as a living room, bedroom, dining room, study room, and service room besides shower, kitchen and laundry room. These rooms can be achieved based on the space need of occupants for daily activity and should be started from the design process of building.

5.1. The following research topic and recommendation

As a preliminary study, the following research is conducted to redesign Dupak Bangunrejo based on a flexible design. The flexible design provides a flexible unit, which has a spacious area, accommodate space changes, accommodate various type households, provide service area, and a proper unit utility. Furthermore, flexible units built in a flexible base building which accommodate to future space requirement, unit plan changes, proper utility, and organize cladding system. In addition, the principle of flexible design for efficiency space usage gives advantages to the built environment in the dense area. Hence, the flexible design is focused on the effort of space usage efficiency in order to meet the space requirements of the occupants. The scheme of the current study and the following research is depicted in Figure 13. In regards to population increased, flexible design concerns to the modular system by using local material and suitable construction technology to the local condition. Hence, the building or unit able to be expanded modularly and remain accommodated without making major changes to the unit. In this flexible design, the space changes relate to the occupants need will not give effect to the unit design.

In addition, the variety and increasing space requirements in units in each household is an important matter for further investigation. Moreover, the analysis of the number of occupant’s activity and time in 18 sqm generates the need for private service area, area requirement, room functions, number of activity, duration of the activity, and the highly needed room. In order to determine an adequate unit size for more than four family members; it recommends the future study to determine the size based on the findings. The lack of privacy within the unit is also a major concern. Thus, a future study can be done to overcome this problem by using flexible infill. Flexible infill in limited unit size is able to organize a variety of occupant space requirements and adapt to changes in space, including future space needs. Refer to the terms of flexible design has to concern to the local resources and condition, meaning that flexible infill has to considers the local materials and construction technology exist in Surabaya. Furthermore, in order to utilize efficient space usage, further study can be done to overcome the lack of space in the unit. One of the efforts is to raise the ceiling at a certain distance. The ceiling height can be used to create space within the unit such as bedroom or storage areas using a hidden simple ladder.

Based on the observation of space usage analysis conducted, public area or living room has free space and the ability to accommodate several activities by configuring loose furniture. This indicates the public area is the best area for occupants in carrying out various activities. Therefore, it is expected that in future research and observations, the study of space

**Figure 13.** The scheme of current study and the following research.
requirement can be developed for different types of households for the same or different size of units, to obtain the space design requirement related to the households’ daily activities in the unit. This is very useful to the best of our knowledge as the main basis for design in order to meet the various activities (households) and future needs of occupants in the unit of social housing, especially for the second larger city in developing country, such as Surabaya.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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