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Providing adaptability of space to ensure sustainable living in low cost housing in Indonesia

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Abstract

Land scarcity made the Indonesian government decided to develop low cost flats to solve the problem for housing the urban poor rather than ground bound single housing (Kementrian PU, 2012). Not all houses offered to the relocated households have shown to be widely accepted (ADB 2003). They were difficult to expand as changing family circumstances dictated. Adaptations to meet the changed users’ requirements involve demolition and result in waste generation which is detrimental to sustainable development (Friedman, 2007). Through activity based analysis, this research aimed to evaluate adaptability of space due to sustainable living in the low cost housing in Indonesia. For this, 300 families of all 14 low cost rental apartment locations were investigated as the total of apartment units in Surabaya was 3459, therefore 21-27 units of each location were taken as sample. Result shows that for functionality, all unit parts of low cost rental apartment units in Surabaya, except the balcony, were provided only between 50% and 55% of the standard. For adaptability, only by the installation of a mezzanine, that fully covering the area of multi-functional space can fulfil the use of space except Tanah-Merah as this upward adaptation could double the area of existing space. The changing capacity for corridor occupation is found to be 1.11, while for the installation of half area mezzanine is 1.5, and for the changing of balcony to a bedroom is 1.16 on average. However, Penjar-3 and I.T.S. could not allow their top spaces as liveable space because their unit height is just 2.65m.

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1. Introduction

Billions of urban poor still live in inadequate settlements within the city with most deplorable living and environmental conditions (UNHABITAT, 2003). Urbanization and fast growing population in the cities in developing countries often result in overcrowding. This happens as the cities offer good job opportunities to villagers that compel them to come to the cities and increase the urban density that result in land scarcity (Komarudin, 1997). To be sustainable and healthy living environment, cities need more green open spaces. All of these problems result in homelessness of the urban poor citizens that cause them to live in slum areas, shanty towns and marginal settlements. UNHABITAT (2003) noted that the rapid growth of cities, the resulting social problems and serious burdens for man and the environment, together with the increasing international pressure to provide a sustainable environment for present and future generations, made the governments of developing countries including Indonesia start relocation and housing programs.

For this, the Indonesian government was urged to do renewals on some dense urban areas to fix the urban planning, safe the urban land and solve the housing problems, as well as improve the quality of human life. This resulted in resettlements of the urban low income households to low cost rental apartments (LCRA) for example in Jakarta and Surabaya, whilst they are generally used to living in individual ground-bound housing units. Despite the difficulties in relocating the urban poor to the apartments, the government will keep developing low cost rental apartment towers to solve the urban problems. This is imperative as the government also needs to enhance the green open space areas within the cities (Kementrian PU, 2012).

2. Theory and methods

2.1. Sustainable houses

Sustainable housing is defined as housing that encompasses the provision of residential buildings in a simultaneous pursuit of a balanced social equity, environmental quality and economic prosperity (people, planet and profit) for the benefit of human well-being. It relates to sustainable development. The principle of sustainable development of a society implies sustaining the fulfillment of the needs of the present population, while also considering the needs of future generations (Friedman, 2007).

![Fig. 1. Balanced state of sustainability](image)

Parallel to Friedman, the purpose of sustainable housing is to create and operate a healthy built environment in such manner that it meets the needs of present generations without limiting the capability of future generations to respond to their demands for a sustainable built environment (Kibert, 2007). It is important then to give attention to two fundamental messages: first are the human needs that may include food, clothing, shelter, and particularly the enhancement of living income to above the standard of the absolute minimum. Second, is the limitation in fulfilling the present needs so that there are remaining sources for future generation.

In the provision of housing, one has to deal with the human needs that primarily involve the use of natural resources such as land, water, energy, materials, etc, as well as human resources, like laborers, experts with skills and knowledge. There are two limitations on resources in housing provision: limitation of natural resources, and limitation of human resources especially for sustainable housing. A lack of these resources will affect housing provision both in terms of quality of the space design as well as in quantity of provided houses. Therefore, a sustainable provision of housing involves inherently an environmental as well as a social dimension as explained in figure-2.
Sustainable housing is achieved when the human and natural resources for realizing the housing units can fulfill the human needs for housing. In other words sustainable housing involves a condition that users’ housing needs should match with the quality of the space design of the provided houses. Recent research underpins that a better match between buildings and users’ real needs will influence the users’ satisfaction. The inhabitants thus might be longer satisfied with the building that leads to a higher level of durability of the building. Ye et al (2009) stated: “It comes down to the fact that there should be a capacity amongst the stakeholders in the construction industry to meet the inhabitants’ requirements”, that expressed by the users, which should be translated into that of the suppliers in the construction industry, to make the houses more functional to the users (Szigeti F and Hammond D, 2005).

In view of sustainability, functionality and adaptability of space design is a premise. Improving the functionality means sustaining the building function to cater to the households’ demands for space. Improving the adaptability means sustaining the functionality of the apartment through the capability of the design to change (a) the function of the functional areas or (b) the dimensions of the space either vertically or horizontally, as well as through the capability of the households to adapt to the available space to cover their changing space demands. The design of the houses should therefore allow change of use throughout the structure’s lifespan. The houses should therefore be functional and adaptable to respond to the present and future social needs of the households by which material and energy consumption as well as pollution can be reduced (Bullen 2007).

2.2. The need for functionality

Functionality of a designed product means that the product works efficiently and effectively for its intended purpose. The design should capable to perform the intended task (Miriam Webster, 2002). Brodt and Smith (2009) stated that one most basic principle of design is to ensure functionality of the building and its operations. A building is said to be functional when it can pertain to the functional program such as spatial needs and requirements, system performance.

Greer (2010) agreed that architecture which is strictly form-based, often fails to function as usable space. The design of Frank Gehry, Walt Disney Concert Hall in Los Angeles, is indicated as an object. The structure is absolutely stunning as a sculptural piece, but it fails to meet many functional requirements of a successful concert space. It means that although form is essential, to be usable, the function of space is of primary importance. West and Emmit (2004) put forward that the most critical issue in housing is spatial functionality. A house that was too small could never be made into a comfortable home. Spatial standards need to be reviewed regularly due to the increased rate of social change. Failure to provide adequate room dimensions or functional spatial design, taking into account the door swings, window openings, electrical outlets, results in uncomfortable or unusable designs. Thus, functionality refers to space design and room dimensions that allow occupants to carry out their (daily) activities. Therefore dimension of the spaces are important determinants.

2.3. The Need for Adaptability

Central in these definitions is the functionality of the building or building component. West and Emmit (2004) described that adaptability is the affordance of dwelling space to fit the changing requirements placed upon it at different times and stages of development family. Geraedts (2001) put forward that adaptability concerns the way on which buildings and building components or facilities can be changed according to the changing users demands, resulting for example in changes in use, changes in number and size of rooms. West and Emmit, and Geraedts
defined adaptability as a way to satisfy users’ changing demands in general. Moffat and Russel (2001) described the changing demands more specifically by defining adaptability as the capacity of buildings to accommodate substantial functional change. A building that is more adaptable will be utilized more efficiently, and stay in service longer, because it can respond to changes at a lower cost. A longer and more efficient service life for the building may, in turn, translate into improved environmental performance over the life cycle. In this case, adaptability is related to efficiency lifetime and environmental sustainability.

Construction is a wasteful sector. Extensive resource usage and demolition can be prevented when dwellings are designed by taken into account the functional lifespan (Friedman 2007). Buildings with relatively short functional lifespan lead to obsolescence, demolition and material waste generation. Waste generation can be prevented when buildings are designed to be adaptable to changing needs of the residents (Kibert 2007, and Friedman 2007). To increase the adaptability, Friedman (2007) stated that the space needs to be free of support walls and permit locations of selected functions such as kitchen, bathrooms, and storage compartments, in whichever place the occupants want.

This research agrees with Geraedts (2001) and Moffat & Russel (2001) who consider adaptability as capacity of space design and room dimensions of buildings to accommodate substantial functional changes required by and without burdening occupants. Thus, adaptability of space refers to the capacity of space design that enables the users to adapt their spatial needs to the available space and change the space design in volume or size and in function.

3. Sustainability of low cost housing in Indonesia

In Indonesia, housing for the low income households is provided by the government and real estates. The space provided is based on standards from SNI, the Indonesian National Standard. Not all houses offered to the relocated households in the social housing programs have shown to be adequate (ADB 2003). No considerations were taken into account with the socio-cultural environment including the daily life and activities of the users. The terms of reference used for houses had no specific consideration for community’s habits and activities (Silas, 2003; Tipple et.al, 2002). Adaptation in order to meet the changed users' requirements requires expensive commercial interventions (UNHABITAT 2003) and involves demolition which is detrimental to sustainable development that envisages a balanced ecological, economic and social development (Friedman 2007).

This research found that the multi-functional space of LCRA units in Surabaya was only provided 50% of the standardized size by the government, the kitchen 55%, and the provision for the bathroom and toilet was 75% on average. Only the balcony was provided more than sufficiently i.e. 116% of the national standard size. As a whole unit, the government provided 51% averagely. This research proposes the revision of the national standard of the whole apartment unit which is originally set at 29.76m², then adapted to 44.94m² (seven un-included activities were added), and finally revised to 48.41m². The number of activities accommodated especially in the multi-functional space on one side produced a high effectiveness, on the other side led the space to conflicts that easily arise not only between the activities, but also among household members. This condition resulted in the need for (functional) adaptation.

4. Changing capacity of space as the solution

The following section is meant to provide solutions by analyzing the capacity of the space in the apartment units in adjusting the available space to the space demands to sustain the functionality of space design that lead to sustainability. The indicator is thus the use of space. The adaptations made include: changing horizontally by partitioning, changing horizontally by occupying the corridor, changing vertically by constructing a mezzanine, and changing the function of balcony to a bedroom.

4.1. Changing in size horizontally by partitioning

This kind of adaptation does not result in additional or extra space, but is applied to solve the problem of privacy. Clashes between private and public activities in the multi-functional space of low cost rental apartments
(LCRA) required adaptation which called for separation of the space by horizontal partitioning. Whether the space is adequate or not, this separation is felt to be crucial for creating privacy. 71% respondents in this research separated their multi-functional space into public and private sub spaces (figure-3).

When the living space is sufficient, there is no problem with the separation of the space. It could be done by just putting a partition in the space. However, when the space is inadequate to accommodate the activities, further adaptations are required. So the judgment of the capacity of the multi-functional space to subdivide it horizontally is based on the adequacy of the provided multi-functional space to offer sufficient space for all activities that are supposed to be carried out there following the real space use for these activities.

![Fig. 3. Horizontal partitioning which is occurred in the multi-functional space](image)

The result shows that the adaptability of the space to be sub-divided in order to enable the conduction of the activities is averagely only 54% of the space use that ranged from 40% at the worst up to 68% at the best. Since there is no extra space created, changing capacity is one (there is no changing capacity).

### 4.2. Changing in size horizontally by occupying the corridor

The corridor occupation generally takes place along the unit. The capacity of the corridor to be occupied depends on the dimensions of the corridor (i.e. the corridor width and the unit length).

- **Capacity of the corridor to be occupied**
  
The key element of the capacity of the corridor to offer additional space to the apartment units is the width of the human body i.e. 0.6m (metric handbook planning and design data). Based on this, a corridor width of 1.2m or less gives no possibility to be occupied. This corridor width is only sufficient for two-way traffic passengers or is the minimum width for public circulation. The possible width to be occupied is the remaining corridor width after being reduced by 1.2m. For a double loaded building the remaining space is shared between the adjacent units as shown in figure-4. For units of single loaded and twin block buildings, the remaining space is directly applied.

![Fig. 4. Example in determining possibly occupied corridor space](image)
The result shows that averagely, the width of corridor that might be occupied is 0.6m. The largest area for corridor occupation, 3.6m², is achieved by Gunungsari as it has the widest corridor width and relatively wide unit. The smallest possible occupation, 0.9m², is found in Tanah Merah as it has narrow corridor and small unit width. The average occupied area is 1.97m².

- Functionality of space when the corridor is occupied
  The new or adapted area after occupying the corridor is area of the multi-functional space plus the occupied corridor space. The adaptability is the new area divided by the use of space. Averagely after occupying the corridor, the units could meet 59% of their space use. The average changing capacity is 1.11 ranging from 1.06 to 1.15 times the available space.

![Fig. 5. The new space area after corridor occupation](image)

4.3. Changing in size vertically by constructing a mezzanine

The patterns in constructing can be: installing mezzanine covering the area of multi-functional space fully; or installing mezzanine on half the area of multi-functional space. The possibility to use the top space for this kind of adaptation depends on the volume (the height) of the unit.

- Capacity of the space to be extended upward
  Not all apartments fitted with a mezzanine can provide a livable top space. The possibility of top space usage depends on the height of the unit space. The required height of the bottom space should be at least 2m. To be able to accommodate activities by standing freely up-right (livable space), the net height of top space should not be lower than 1.7m, which is similar to the average Indonesian human height (BPS). So the ideal net height of the adaptable space for LCRA units in Indonesia is at least (2+1.7) = 3.7m. As the highest unit space of LCRA in this study is only 3.4m, the ideal height 3.7m can only be achieved by the units located on top floors. Despite being illegal, here households could heighten their ceiling by breaking into the roof space/attic (figure 6). Therefore, normally the top spaces in this research can only allow sitting activities which required height is 1.2m. For this, top spaces with net height between 0.8m to 1.2m are only able to be utilized as flexible storing space, which in urgent situations often be used as sleeping area. Top spaces lower than 0.8m can only be utilized as limited storing space which depth must only be within human reach.

![Fig. 6. Advantages of units located on top floor in terms of mezzanine construction](image)
With the structural thickness of mezzanine flooring is considered 15cm and 1m high top space is acceptable as limited liveable space, the result shows that when the height of the bottom space is set 2m, among 14, only 3 LCRA top spaces are considered limited and liveable space. By lowering the bottom space to 1.8m, the total of limited and liveable spaces becomes 6, and the other 6 become flexible storing space that can be used as sleeping area in urgent condition. Only Penjar-3 and ITS do not allow its top space as liveable space as their unit height is just 2.65m.

- Functionality of the space when mezzanine is installed
  The new or adapted size of multi-functional space after the construction is either 1.5 times or twice the original area of multi-functional space indicates the changing capacity.

![Fig. 7. The new space area after mezzanine construction](image)

The result indicates that by installing mezzanine half the area of multi-functional space, only Gunungsari and I.T.S. could meet the use of space, while the rests only achieved 61% up to 93%. However, by installing a full-size mezzanine it is found that all LCRA met the requirements except Tanah-Merah that only reached 81%. Full mezzanine construction is thus effective to functionalize the space. The average changing capacity of space design when half mezzanine is installed is 1.5, and when the constructed mezzanine is full the changing capacity is twice the available space.

4.4. Changing the Function of Balcony into a Bedroom

The changing in function is not only in order to complete the functional areas within the unit, but also to meet the changing demands including the increase of household members as well as the need to solve clashes between private and public activities. The space that usually needs to be expanded is the bedroom, living room, or storage. The most possible unit part that likely to be changed is the balcony. The private space in need of expansion is usually the sleeping area. Therefore this evaluation assessed the possibility of balcony to be changed to a bedroom.

Households who performed this change were mostly those who lived in units with collective services as they had fairly large balcony. The pattern of doing this is usually by changing the entire space of the balcony into a bedroom. Thus, the broad space after changing of function or the new area equals to the area of the multi-functional space plus the area of the balcony (figure-8). The adaptability of the adapted space is the new area divided by the use of space, while the changing capacity is the new area divided by the provided space.

![Fig. 8. The new space area after changing the balcony into a bedroom](image)
• Functionality of the space when the balcony function is changed into a bedroom

The result shows that Gunungsari with 77% in meeting the use of space has the best adaptability, followed by Dupak with 72%. The least adaptability 54% is found in Waru Gunung and Tanah Merah. Averagely, after changing the function of the balcony into a bedroom, the provided space can meet 62% of the use of space. The average changing capacity is 1.16 times. The highest changing capacity was obtained by Tanah-Merah with 1.33 times, while ITS had the lowest by 1.03 times the provided space.

5. Conclusion

This study found that only the installation of a mezzanine with fully covering the floor area of multi-functional space can fulfill the use of space or the space requirement. This is possible as full mezzanine installation can double the original multi-functional space floor area. In other words, the changing capacity that can be created from this vertical extension is twice the provided space.

With the fulfillment of family demands for space that correspond to the extent necessary, the daily household activities can be performed more properly so that they would stay longer pleasantly in their house or apartment unit. There should be no more reshuffle that resulted in the destruction of the space which may increase construction waste and interfere the environment.

References