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The Stakeholder Requirements of Building Systems for Coastal Low Income Housing Concerning Safety and Adaptability

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Abstract

Many coastal settlements in humid tropical developing countries face the burdens of risks due to their location as well as due to a rather low quality of housing that does not meet the requirements of sustainability. An important aspect is that the provided building systems for coastal houses in some developing countries (DCs) do not cater for the stakeholder requirement of building safety and adaptability in the coastal area. This paper describes the results on stakeholder requirements and preferences of building systems for determination and adaptation of the performance of low cost housing in HTCCs towards improved sustainability concerning safety and adaptability.

Keywords : *stakeholder requirements, sustainability and lifespan, building systems, humid tropical coastal cities , safety and adaptability*

1. Introduction

Nowadays, there are an increasing number of countries in the world that provide a sustainable environment for present and future generations. It involves the simultaneous pursuit of social equity, environmental quality and economic prosperity (people, planet and profit) (UN 2005). Together with solving the housing problem for the urban low income households in a sustainable lifespan based manner, sustainability has become one of the most urgent imperatives in many tropical DCs. This counts particularly for coastal settlements that have to face natural hazardous impacts. (UNHABITAT 2003).

To decrease sustainability problems, it is necessary to gain more insight into and understanding of the sustainability of building systems in different societies and locations in coastal areas. Given the particular context of low income household in coastal tropical urban settlements in developing countries, important aspects that need to be investigated are safety of the building systems.

This research project explores the potential for building systems to contribute to meeting the stakeholders' requirements for Lifespan Based Sustainability (LBS) of low-cost housing in humid tropical coastal cities (HTCC) in the northern part of Java Island. The LBS of low-cost housing refers in this project to the extent to which the buildings and their components (1) meet the stakeholders' requirements for the living environment in terms of safety and adaptability, and (2) demonstrate long term responsibility to the natural environment in terms of a-reduced waste generation.

The rapid growth of cities, especially in developing countries, continues to leads to social problems as well as to serious burdens for the both humans and the environment (UNHABITAT 2003). Indonesia is a country with more than 17,500 islands. The countie's 81.000 km coast line means that 25 % of the population lives in a coastal settlements (Dahuri,R, et all; 2001). The housing conditions in these settlements are more often than not unsuitable for habitation. Infrastructure, services and physical facilities are still limited; clean water is difficult to acquire and sanitation is improper. The populations here generally have relatively low income levels (Dahuri, 2001).

Low-cost houses, with different layouts and building systems, have been built for lower income households through various public housing programs. These programs have aimed to alleviate various housing problems in many tropical developing countries, particularly in densely populated urban areas where land is rather scarce. Not all of them have shown to be adequate or widely accepted for implementation alike in the coastal areas of Java in Indonesia (ADB, 2003). While newer- modern construction methods are obviously in place within HTCCs, a large percentage of new construction still utilises building systems that appear to be un-sustainable. An important aspect in this regard is that the provided houses do not cater to adaptation and extension in response to the present and future social needs and demands of the households. For example having extra space for home based enterprises is an essential ingredient for the sustainable livelihoods of a majority of the low income population. (Silas, 2003;Tipple,et.al, 2002;Septanti,2000). This implies that the design of the houses should allow for changes in use throughout the structure's lifespan. In other words, the houses should be *adaptable and flexible* to respond to the present and future social needs and demands of the households. Such ideas are not new. In the late 1970's, John Turner (1976) posed that local communities themselves must have control over major housing decisions so that they can be more responsible for design decisions that better take into account their own present and future needs and demands. Furthermore, all adaptable buildings are inherently more sustainable because they reduce material and energy consumption as well as pollution. (Johnstone,1995; Binder,2003, Bullen, 2007). But unfortunately, despite the recognised importance of the adaptability of buildings, reality show that a full integration of this concept is rarely achieved.

From the above can be concluded that current of constructing houses, including simply allowing housing corporations to provide houses for lower income populations, does not respond to new demands for sustainable and adaptable building construction in the dynamic societies of the 21st century. It is also questionable as to what extent such innovative building systems when applied to low-cost housing in HTCCs in developing Asian countries, such as Indonesia, India and Vietnam, actually will respond to occupants' needs for safety, particularly in coastal urban areas.

This paper therefore deals with problems associated with the lifespan-based sustainability of building systems as they are applied to low-cost housing in tropical, coastal urban settlements in a developing country such as Indonesia, with a particular emphasis placed on user requirements for safety and adaptability.

2. The Safety and Adaptability of Building Systems for Low-cost Houses in Coastal Area

There are two essential factors that show to indicate the quality of building systems for low cost houses in coastal areas. Coast due to both geographic and location and geologic instability strongly need requirements to strengthen building construction especially for low cost houses. This requirements not only to prevent construction damage that may happen from their instable soil, but also from natural hazard like wind storm, tidal flooding, tsunami and others. Besides, building systems in coastal areas have to meet user needs that change over time. It means the adaptability of building systems has to consider in order meeting this requirement.

According to FEMA (2005), the safety of building systems for the coast low cost houses is defined as the success in systems from coastal hazards and processes over a period of decades that indicate by the capability of them to resist damage. This statement does not indicate that the buildings have no damage over its intended lifetime, but they have to imply that the impacts of its design to the natural hazard will be limited. This can be determined by the quality of building construction, such as the strength of main structure, design of building components and a layout design plan. Furthermore, these requirements will be indicated by the safety of occupants from loss live and injure. Building construction have to meet several requirements such as resistant to geographical conditions according to the position and meet the standards intended for building in coastal areas. This is based on the global issue that houses in coastal areas have the highly risk because of the geographical vulnerable conditions that affect unstable soil and high risk to the waves attack and sea level rises (Zainuddin Z.A, 2004; Ekawati, Y, 2004).

There is a multitude of definitions for adaptability; which coincide with concepts such as flexibility. Important determinants of adaptability derived from the literature are *generality* (change of function without changing characteristics); *elasticity* (increase or change of function by possibilities to attach parts to, or detach parts from other building parts) and *flexibility* (change of function by changing the technical structure at minimal costs and abruptions to operation). (Blakstad 2001, Ball,2002; Mansfield, 2002; Douglas, 2006; Bullen, 2007). Central in these definitions is the *functionality* of the building or building component.

According to Marfa'i, M.A, et.al; (2007); an adaptable house is one which is able to respond effectively to changing occupants' needs without requiring costly and energy intensive alterations. This will accommodate lifestyle changes without the need to demolish or substantially modify the existing structure and services.

Thus, Tipple,2000; Silas, 2000 and Septanti,2000, show that the most important adaptation in low cost houses is how users have possibilities to re-arrange, re-adjust and add space due to meet their needs over time without mayor destruction. There are some examples of adaptability found at research, such as: addition partition to separate the space for bedroom, using the communal alley for home based enterprises (HBE) activities, using the attic space for storage, work place and others. The reasons why occupants want to adapt their housing

building systems are the growing of family, activities, different needs because of age and socio-economic reasons. All of the reasons are proven community based.

The adaptability of meaning in this research will emphasized *generality:* the change of functions without changing characteristics, and *elasticity*: the increase or change of function by possibilities to attach parts to, or detach parts from other building parts. That can be determined by the possibilities of living space to re-arranging, re-adjusting and adding according to the changing users needs over time.

Thus, it can be concluded that both safety and adaptability are essential to indicate the strength of low cost house building systems especially built in the coast, so that person who responsible to this area have to consider them as the most important factors that influence the quality of buildings.

3. Variables and Attributes of Building Systems Based on User Requirements

Variables and attributes that determine in this research were classifying into 3 main categories:
1. The strength of main structure
2. Design of building components
3. A Lay out Design Plan

There were variable and attributes that indicated building safety. The strength of main structure was indicated by the level of physical damage, the condition of building components and material used. For the second classifications, design of building components was indicated by building systems that used for building design. Finally, a lay out design plan was indicated by design of layout and building orientation. The adaptable of building systems was determined by user satisfaction and preferences for the connection / junction systems between components. This paper will explain the kind of users' requirements by using those all indicators.

4. User Requirement and Preferences for the Building Systems of Low-cost Houses in Coastal Area

4.1. Coastal Housing Types in the Northern Part of Java Island

Low-cost Housing (LCH) in the northern part of Java Island, Indonesia was limited to formal projects established in the period between 1990-2005. During this period, *Perumnas* (National Housing program) and *Apersi* (Low Cost Housing Developer Association) built 149,877 houses in the coastal cities. Of these, 29,975 (20 %) of the houses were built along the northern part of Java (source data by : *Perumnas* and *Apersi,* 2009).

Following secondary data, such as drawings, housing plans, technical specifications and other documents, the formal housing projects can be classified by the main structure, primary components and materials used. The housing classification has been divided into 4 types:

Housing type 1 : Continuous footing with plastered red brick
Housing type 2 : Continuous footing with plastered white brick

Housing type 3 : Single footing with plastered *batako*
Housing type 4 : Single footing with non-plastered *batako*

1.

2. *Table 1 : Classification of housing by type, location and percentage*

No	Housing Type Drawing/ 3 D Design	Location	Approximately percentage of housing type (%)
1	Continuous footing with plastered red brick	V Zone : Semarang, Demak. C Zone : Surabaya, Kendal, Tuban. A Zone : Surabaya, A Zone	50 %
2	Continuous footing with plastered white brick	C Zone : Tuban , Bangkalan. A Zone : Tuban	15 %
3	Single footing with plastered *batako*	C Zone : Bekasi A Zone : Bekasi	10 %
4	Single footing with non plastered *batako*	A Zone : Gresik, Surabaya C Zone : Semarang	25 %

(Source : authors)

4.2. The Safety of Building Systems Due to Meet Users' Requirements

In order to meet users' requirements to the safety of building system, Zainuddin Z.A (2004) and Ekawati, Y, (2004) was proposed the quality of building systems as a main factor to indicate them. Based on SNI no. Dept of Public Work of Indonesia, housings' physical condition is one indicator to determine the quality of building. The measurements will identify by users' satisfaction and preferences to housing physical conditions, building components and material used. Based on the primary data taken in field survey, it can be seen on the table below:

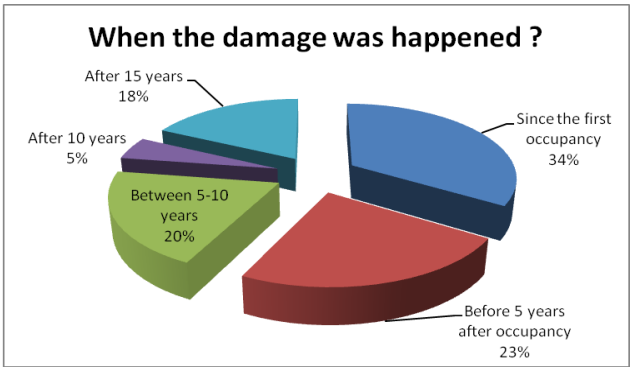
Table 2. The percentage of housing damage by classification of housing type.

Housing Type	Percentage of housing by damage classification			
	1	2	3	4
1	45.97 %	23.39 %	4.03 %	1.61 %
2	1.61 %	0	0	0
3	4.84 %	0.81 %	1.61 %	0
4	8.87 %	6.45 %	0.81 %	0
TOTAL	61.29 %	30.65 %	6.45 %	1.61 %

This table shows the physical condition of housing type 1 (continuous footing with plastered red brick) was the highest number of percentage with 45.97 % with non-structural light damage. Thus, 23.39 % houses were indicated with light structural damage and 4.03 % medium structural damage. After that, 1.61 % houses were indicated heavy structural damage in the first occupancy.

It can be concluded that the majority of houses have not major structural damage, however more than 30 % indicate with light structural damage.

Based on field survey, most of users (34%) claimed that the damage was happened since the first occupancy; however it was no structural light damage. After that, 23 % users said that it was happened before 5 years, and 20 % said it was happened between 5-10 years. The damages were happened after 10 years occupancy strongly accepted by users (23 %).



Following by cross tabulation analysis between housing' type and length period of damage happened after the first occupancy, there is the correlation between them. The highest value was contributed by housing type 1 with damage happened since the first occupancy. It can be concluded that there is a number of reasons that cause of the damage. Crack and damage that happened since the first occupancy indicate the low quality of material used to construct the building. The percentage of user satisfaction to building components can be seen by table below:

Table 3. The percentage of user satisfaction to building components

Building components	Level of user satisfaction				
	1 Very unsatisfied	2 Un satisfied	3 Average	4 Satisfied	5 Very stistied
Structure	0.083 %	4.17 %	50.83 %	44.17 %	0
Wall	0.083 %	5.83 %	58.33 %	35 %	0
Floor	0.083 %	0.05 %	55 %	39.17 %	0
Roof	0.083 %	1.67 %	47.5 %	50 %	0

The table shows that the most of users satisfy to the structural (44.17 %) and other (50.83 %) feel in between (average). For walls condition, almost 35 % users satisfy and other 58.334 %) feel in between (average). Floor condition with 39.17 % and other (55 %) feel in between (average). The last, roof with 50 % users are satisfied and other (47.5 %) feel in between (average).

This situation shows that the most of users satisfy with the condition of the housing in the first occupancy (after construction). Although no structural light damage that indicated by physical condition of the roofs seems high, but users satisfy seems in the equal position for them (roofs). This can show that most of users were accepted with the general condition of the houses.

Following by cross tabulation analysis between housing' type and physical condition shows that there is the correlation between them. The highest value was contributed by housing type 1 with non-structural light damage in the first occupancy.

4.3. The Adaptability of Building Systems Due to Meet User Satisfaction

There are an increasing number of adaptations due to meet users' requirements to building systems that applied in the coast. First of all the adaptability was done because of both geographical location and geologic instability. People create some renovation to adapt with this vulnerable condition. Thus, another reason was proposed because of the change of users needs over time. The explanation of both reasons will be presented below:

4.3.1. Housing adaptability due to solve the coast problems

Housing position was the main factor that influences those houses attack by tidal flooding. The percentage of housing that attack by tidal flooding can be seen on table below:

Table 4. The percentage of housing that attack by tidal flooding

Housing Position	The percentage of housing that attack by tidal flooding		
	Yes	No	Total
Zone V	10.57 %	0 %	10.57 %
Zone C	19.51 %	29.27 %	48.78 %
Zone A	0 %	40.65 %	40.65 %
	30.08 %	69.91 %	100 %

This table shows that 30.08 % of houses in coast were temporary attack by tidal flooding and others (69.91 %) not. Although the most houses never attack by tidal flooding, users strongly need to renovate them by some reasons. Due to meet users requirements, the adapted of building systems create on those houses. There are some kinds of adaptation, such as raised floor level (36.06%). The other reasons are create a barrier walls (6.55 %), and alternative material for barrier wall (sands sacks, etc) with 11.47 %, and others renovated their house because of damage or have no economics ability (economic reason).

The houses that renovated that cause of damage usually since wet wall due to groundwater seepage (13.7 %), the crack of walls (47.94 %), the peeling of wall plasters (23.28 %), the falling of ceiling (4.11 %), the reason of structural damage (1.4 %) and others reasons (9.59 %). According to users, renovation that held to adapt their requirements is heavy renovation (almost all renovated) approximately 26 %, medium renovation is 20 % and small scale renovation 54 %.

These data shows that the most of housing were on the safe position from attacked by tidal flooding but unsecure with the cause that happened by their position in the coastal area.

4.3.2. Housing adaptability due to solve user needs over time

There are an increasing number of reasons causes of renovating the houses. Not only the damage of housing components but also by users requirements have that changed over time. Based on field survey, almost 83.6 % of users were renovated their house because of this reason. Accessibility reason (uncomfortable circulations) with 7 %, houses unfit for habitation (too small over time) with 9 %, unsuitable with changing times (excuse mode) 6 %, changing of

family member needs 22 %, changing of activities (domestic or home enterprises) 54 %. This explanation can be seen on the table below:

Besides, users also renovated their house by rearranged the room 13.4 %, changing the opening position 1.68 % , reposition space 10.08 %, addition enclosure (non structural) 3.36 %, additional space (structural) 60.50 % and other reasons (10.9 %). According to the users, the renovation of their houses was took 1-3 days 1.75 %, it was took more than 3 days 0.88 %, it was took more than a week 14.91 %, it was took more than a month 82.48 %. This period shows the difficulties of renovation done.

Based on the research was done, it can be concluded that although to add space structurally need more sources, but this way also consider by users in order to meet their requirements.

5. Conclusion

Following from the explanations contain in this paper, it can be concluded that:

1. Both safety and adaptability are essential factors to indicate the quality of low-cost houses' building systems especially built in the coast.

2. There is various kind of damage that happened during occupancy. To begin with is the non-structural light damage until the highest one is total damage. This kind of damage can be cause of structural reasons, quality of materials used and how to build these houses.

3. Most of users were not renovated their house because of the damage reasons. Additional space is the highest reason to modify their house. In order to meet their requirements, although to add space structurally need more sources, but this way also consider by users.

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