MAN AND SUSTAINABLE LOW INCOME HOUSING

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ABSTRACT

The importance of concern for the human dimension in sustainable design and engineering solutions for housing is the issue discussed in paper. It is based on literature studies. Sustainable housing encompasses the provision of residential buildings in a simultaneous pursuit to well-balance three dimensions: (1) economic dimension; (2) ecological dimension; (3) social or human dimension. This implies the promotion of capabilities by which individuals can fulfill their needs in ways that best suit them; consistent with their socio-cultural values and affordability whilst not exhausting the natural environment. The housing backlog and the need for adequate housing especially for low income households is still high in many countries. To cope with housing problems, Low Income Housing projects were carried out throughout the world. The literature studies showed that the majority of research on functionality and adaptability of the houses to meet the requirements of individual households has taken place in advanced countries. Most studies tended to focus on technological issues being divorced from user demands, lifestyle and domestic activities. Further research onto the human dimension in design and engineering solutions for sustainable low income housing in DCs is evident.

Keywords: *sustainable housing, low income households, functionality, adaptability, human dimension*

ABSTRAK

Makalah ini membahas pentingnya kepedulian terhadap dimensi manusia dalam arsitektur berkelanjutan dan solusi rekayasa untuk perumahan. Hal ini didasarkan pada studi literatur. Perumahan yang berkelanjutan meliputi penyediaan bangunan tempat tinggal dalam pencapaian simultan baik untuk keseimbangan tiga dimensi: (1) dimensi ekonomi, (2) dimensi ekologi, (3) dimensi sosial atau manusia. Ini berarti promosi kemampuan dengan mana individu dapat memenuhi kebutuhan mereka dengan cara yang paling sesuai dengan mereka, konsisten dengan nilai sosial-budayanya dan terjangkau, tidak merusak lingkungan alam. Kekurangan perumahan dan kebutuhan perumahan yang layak terutama bagi rumah tangga berpenghasilan rendah masih tinggi di banyak negara. Untuk mengatasi masalah

perumahan, proyek perumahan bagi masyarakat berpenghasilan rendah dilakukan di seluruh dunia. Studi literatur menunjukkan bahwa sebagian besar penelitian tentang fungsi dan adaptasi dari rumah untuk memenuhi kebutuhan rumah tangga telah terjadi di negara-negara maju. Kebanyakan penelitian cenderung berfokus pada masalah teknologi yang terlepas dari permintaan pengguna, gaya hidup dan kegiatan domestik. Penelitian lebih lanjut ke dimensi manusia dalam solusi desain dan rekayasa untuk perumahan berpenghasilan rendah yang berkelanjutan di DC jelas.

Kata kunci: *perumahan yang berkelanjutan, rumah tangga berpenghasilan rendah, fungsional, kemampuan beradaptasi, sisi kemanusiaan*

INTRODUCTION

In the following sections the importance of concern for the human dimension in sustainable design and engineering solutions for housing will be discussed. It is based on findings of literature studies. These indicate that past research on low income housing tended to focus on technological issues being divorced from user demands, lifestyle and domestic activities. Those studies that were directed to functionality and adaptability of the houses whilst taking into account the human dimensions such as the particular requirements of individual households took place in majority in the developed world. The authors conclude that further research onto the human dimension in design and engineering solutions for sustainable low income housing in Developing Countries is evident.

Housing

A house is for all human beings a basic need. A traditional list of immediate "basic needs" of man includes food (including water), shelter, and clothing. Maslow's theory (1954) suggests that these basic physiological and safety needs must be met before man will strongly desire higher level of needs, such as social and psychological needs like social belonging and acceptance as well as self-esteem and self-respect.

The needs for food, air and water are metabolic requirements for human survival, whilst clothing and shelter provide the necessary protection from the elements and from natural as well as from man-made hazards like natural disasters, terrorist attacks, war, etc.

Adequate shelter indisputably is imperative for personal and financial security, for man's health and well-being. It also forms a safety net against accidents, disasters, illness and their adverse impacts. Additionally adequate shelter supports in meeting social and psychological needs whilst providing space for all kinds of social groups, such as housing for families, work environments for enterprises, professional organi-

zations, meeting places for clubs, religious groups, sports, etc. After all, shelter may support man's need for esteem: a need for status, recognition, fame as well as man's need for self-respect, independence and freedom.

Quality of Life

In other words adequate shelter plays an important role in providing a quality of life to people. Quality of life is context specific in meaning and hence it may differ from one context to another. Quality of life describes "individuals' perception of their position in life in the context of the cultural and value system in which they live and in relation to their goals, expectations, standards, and concerns (WHO, 1998). As a concept, it thus seeks to enable individuals, as far as possible, to achieve their goals and choose their ideal lifestyle within the possibilities of their environment (EFILWC, 2004).

An individuals' quality of life may be measured not only in terms of satisfaction, physical and mental health, finances, education and training, employment, career, family life, for example, but also by the quality of the physical environment in which one lives (Moser, 2010). This relates to the quality of the house as a 'homestead', as well as the surroundings of the house. As a homestead, the house constitutes a family's habitat with the basic function of domesticity, identity formation and realisation of ideals (Lawson, 2006 & Sparke, 2004). It provides the needed environment for continuity, privacy, security, self-expression, socialisation and warmth (Mustafa, 2010). Affordable and appropriate housing protects people from hazards and promotes good health and wellbeing.

In any case Article 25 of the Universal Declaration on Human Rights (adopted and proclaimed by the UN General Assembly resolution of 10 December 1948) states that: "Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care. and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control" (UN, 1948). In this perspective many countries alike the USA in its 1949 Housing Act indicated that their national goal is to strive to the achievement of a decent home and living environment for every family.

Sustainable Housing

Sustainable housing is a concept which definition is based on that for sustainable development formulated by the WECD (1987). Sustainable housing is considered to encompass the provision of residential buildings in a simultaneous pursuit of a balanced social equity, environmental quality and economic prosperity for the benefit of human well-being (people, planet and profit). Sustainable housing thus includes a well-balancing of three dimensions: (1) economic dimension; (2) ecological dimension; (3) social or human dimension. The objective of sustainable housing is the creation and operation of a healthy built environment in such manner that

it meets the needs of the present generation without limiting the capability to respond to the demands of future generations for a sustainable built environment (Kibert, 2005).

This definition embraces two major aspects: (1) human needs for basics - such as food, clothing, shelter, income and for conditions to maintain and up-lift an acceptable life standard above the absolute minimum; and (2) limits to the capability to fulfil the needs of the present and the future generations. Meeting the human needs, at least the physical needs, involves the use of scarce resources: land, natural resources, capital, labour, skills. Building construction has to deal with limits of capabilities in terms of the finite natural resources (energy, materials, water) and of the human capabilities for the development, diffusion, acquisition, adoption, and implementation of technology and knowledge in residential construction. The human dimension thus is inherently present in sustainable residential construction.
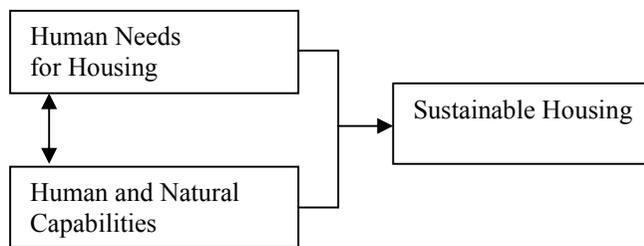
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┌─────────────────┐
│ Human Needs     │──────┐
│ for Housing     │      │      ┌──────────────────────┐
└─────────────────┘      ├─────▶│ Sustainable Housing  │
        ▲                │      └──────────────────────┘
        │                │
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┌─────────────────┐      │
│ Human and Natural│─────┘
│ Capabilities    │
└─────────────────┘
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Figure 1. Theoretic framework

To achieve a quality of life by sustainable housing, therefore, implies the promotion of the capabilities by which individuals can fulfill their needs in ways that best suit them, consistent with their socio-cultural values and affordability without exhausting the natural environment. If such capabilities for housing are available, affordable, equitable and viable, in both the short and long-term, housing is considered to be sustainable (Adams, 2006). Thus, sustainable housing contributes to improving the quality of life through the application of capabilities (skills, knowledge, principles and practices, materials and methods, strategies and solutions) which meet man's requirements in the present and the future.

Since the turn of the century, there is a widespread understanding and awareness of the importance of sustainability, enhanced by a sudden global awareness of the threat posed by the human-induced climatic change in majority produced by deforestation and the burning of fossil fuels.

Basic Housing

Basic housing is the process by which even the poorest of families is enabled to have access to affordable shelter and services like drinking water and sanitation. The two most common forms and most important low-cost housing approaches followed

throughout the world to provide basic housing encompass community upgrading and sites and services projects. The main principle behind the provision of basic housing is progressive development. The idea is that shelter and services can be initially provided in the simplest and cheapest way and housing then can be gradually improved in stages, using the combined resources of the people, community, government, and other institutions. In these processes, the shelter and services that evolve are in response to the basic needs of the people and their inherent capabilities to achieve those needs. Governmental programs are assumed to assist and augment personal and community capabilities. Many national, international and bilateral agencies, such as the World Bank, European Development Fund, Canadian International Development Agency, and Asian Development Bank, have supported basic housing programs to tackle housing problems (Laquian, 1983).

RESULTS AND DISCUSSION

Housing Problem

The rapid growth of cities leads to social problems as well as to serious burdens for human health and the environment. Billions of people live in slums and shanty towns, in cities and countries around the world, many in tropical areas, doomed by ongoing poverty to grossly inadequate shelter. Although population growth has decreased the demand for adequate housing and the housing backlog is still high in many countries. The global housing problem is one of a tremendous magnitude both in quantity and quality. Qualitatively, most of the existing dwellings are characterized by the lack of sufficient space, durable materials, water and sanitation, etc (UN-Habitat, 2006). In the absence of a consistent program of maintenance and repair, most housing stock is also fast deteriorating. Given the rise in urban population, the pressure on the existing stock will increase greatly, occupancy rates will grow accordingly and the quality of life can be seriously compromised. There is quite some literature dealing with the issue of housing for low income households (LIHs) which has been published ever since the 1960s. Also recent publications stress the problematic housing situation for especially the urban poor (UN HABITAT 2006 & UN/MDG, 2008).

Those regions in the world with an enormous demand for housing are simultaneously repeatedly struck by hazards such as earthquakes, flooding, volcanic outbursts, armed conflict etc. Developing Countries (DCs), where a large percentage of the population still lives in extreme poverty and where hundreds and thousands of people need safe shelter, have become even more vulnerable under these circumstances.

The different media report natural disasters almost daily. This mostly concerns hurricanes, floods, volcanic eruptions, earthquakes and recently tsunamis. The impact of these so-called acts of God is often very large, both in terms of material damage and in number of victims. Floods, mainly caused by heavy rainfall are the most

common and widespread of all natural disasters, except fire. They often bring about violent landslides, contamination of water supplies, etc. The effects are evident. Global warming increases overall sea levels and riverbed levels rise due to siltation, leading to even more chance for flooding. Man-made disasters such as dam failures (usually resulting from neglect, poor design, or structural damage due to a major event such as an earthquake) cause floods with even more devastating effects (Wilbanks, 2007).

Many hurricanes develop every year in the six main areas around the equator, mostly in DCs. Many strike islands or populated coastal zones of continents, causing major structural damage to buildings making many people homeless and causing loss of life. Some buildings are damaged by virtue of their siting and position (for example near the top of a hill). Conversely, many buildings resist hurricanes very well because they are in a locally sheltered position (e.g. by natural windbreaks such as trees or by other surrounding buildings). Particular geometric building shapes (tall buildings, parapets or other architectural features like large roof overhangs) are vulnerable. The experience with earthquakes showed how most of the modern buildings, constructed in accordance with the building regulations, are able to undergo the earthquakes rather well, whereas others did not survive. There are generally large numbers of earthquake victims in old and poorer parts of cities or in rural areas, due to a lack of attention paid to earthquake resistant building in these locations.

By far the majority of structures fail because of man's failures to make proper construction details. In general this arises because the natural forces that can be exerted are not fully appreciated either at the design stage or at the construction stage when site supervision is inadequate, so that the houses are not constructed according to plan. Moreover the majority of houses in the world (low-rise houses) are not designed at all they are built by home owners or small contractors, using traditional methods and without any specialist building knowledge. On the other hand there are many homesteads in rural settlements which are traditionally constructed in a hazard-proof manner. For example houses in coastal areas in a number of South-East Asian countries are generally raised above maximum flood levels and stand on stilts so that floodwater can pass through. Knowledge and skills are passed on from fathers to sons. In a number of countries it is formalized in National Building Codes which specify that the lowest floor, including the basement, of any building located in a flood area shall not be located below the design flood level (Wiseman, 2008). In many DCs however there is little or no professional design and engineering input to make the self-built houses disaster-proof. If the amount of damage that occurs due to disasters is going to be reduced, it is important that this capability is increased.

Social Housing in Urban Areas

To cope with housing problems, residential construction for LIHs (Social housing) has taken place throughout the world. Social housing provision started in the western developed countries (Europe, the US and Australia) to provide housing for the

labour force in urbanizing areas during the industrialization era at the beginning of the 1900s. The immense volume of housing built in the era after World War 2 led to the emergence of a comprehensive set of minimum standards for social housing, such as those standards set in the Netherlands. Dutch standards (Voorschriften en Wenken, 1965) were developed in the 1960s to be used as a basis for government support to social housing projects. Many studies were carried out during this period on the design and spatial arrangements of the houses such as kitchen lay-out, size of the rooms, etc, derived from aspects such as average household composition and daily use of the house by a common-denominator group of users. Social housing projects in the world showed a large uniformity in spatial arrangement of the houses. The houses could not easily be adapted to the requirements of individual households. At the turn of the century housing policies have changed towards more attention to human dimensions and the actual requirements of household members in a number of countries (e.g. Dutch Housing Memorandum 2000-2010 'What people want, where people live'). More individual freedom of choice for the citizen is the point of departure (Priemus, 2001). So people will have more say regarding their housing and living environment. Other aspects of these policies include more attention paid to societal values: creation of opportunities for vulnerable people, promotion of tailor-made (combined) housing and care, improvement in urban housing quality and facilitation of green housing preferences. It is a pattern recognizable in many countries in the globalizing world.

In Singapore, public housing started already in the 1920s during the British colonial period to alleviate the deplorable housing conditioning downtown Singapore. The severe housing shortage in Singapore after World War 2 stimulated the establish-ment of the Housing and Development Board (HDB) in 1960 to develop public housing (mostly meant for rental by the low income group) and improve the quality of the living environment for all residents. Singapore has been successful by starting with 1 room housing for the lowest income groups whilst at the same time income generation and economic development was stimulated. Singapore could experience a tremendous economic growth and currently public housing involves at least 3 rooms per apartment (Tan and Sock Yong, 1991). Mexico is an example of a middle income developing country where public housing started after World War 2 to decrease the immense housing shortage in rapid urbanizing Mexico city. The hou-sing shortage was due to a demographic boom and at the same time enriched by US inversion and an oil boom. New towns in suburbs were developed following exam-ples from the US. In most DCs (and former colonies of western countries) social housing projects started after independence (1960s).

Sutainable Low Income Housing: Policies and Strategies

Many studies have been done during the past decades on various aspects of low-cost housing schemes in low and middle income DCs (e.g. Jephcott, 1971; William and Wheaton 1972; Turner 1976, 1983; Kimm, 1987; LaNier, Oman, and Reeve, 1987; Malpezzi, 1994; UNCHS, 1995, 1996; UN HABITAT, 2005, 2006; ADB, 2003).

Literature showed that housing in DCs in the past research has primarily been viewed as a policy issue and physical phenomena to be looked upon in terms of construction costs, material inputs, finish and asset worth. Providing adequate, quality and affordable houses for the LIHs has remained one of the principal policy objectives of governments, all over the world. Several approaches have been tested with mixed results (Tipple and Korboe, 1998; Arku, 2009; Obeng-Odoom, 2009).

In a number of countries policies focused on direct intervention through mass public institutional or formalized housing schemes financing, subsidizing, producing and administering housing, while simultaneously controlling rent and regulating the housing market. Over time, the weaknesses of this approach shifted the government's role as a provider to a facilitator, creating the 'enabling' environment for private sector participation. This involves improving institutional frameworks and strategies (e.g. site-and-service schemes, settlement upgrading, tax holidays for developers, tax rebates on building material production, regularization of land tenure, deregulation of the housing market, establishment of mortgages finance systems, cooperative housing, etc). Although many of these efforts have had LIH as target, studies by Tipple and Korboe (1998), revealed that contrary to policy objectives, production figures show a dominance of upper and middle income group housing projects. Building on this work, Arku (2009) concluded that although one of the key goals of the reforms was to make housing accessible to the urban poor, this failed woefully to be within their reach.

Besides the problem of accessibility, many publications also indicated that housing for the urban LIHs fails to meet demand in terms of quality (and hence habitability) notified by most deplorable living conditions within the city with overcrowded housing units, a lack of privacy, inadequate water supply, facility sharing, poor sanitation, a lack of drainage and waste disposal systems and dilapidated habitation on hazardous locations, insecure tenure and vulnerability to serious health risks. Characteristically, less policy attention is given to the physical quality in terms size, relative to the number of inhabitants, how it is designed and built, such as the quality of materials used, access to basic infrastructural services, etc (Breddnoord & van Lindert, 2010).

Research attributes the above situation to several factors. Some scholars argue that most of the policies are 'income-blind' resulting in a situation where 'affordable' housing becomes only within the economic capacity of the high income group, who purchase and lease or rent the houses to the low income at cut throat prices. Gann and Barlow (1996), refer to this as an 'affordability gap' the gap between mean incomes and mean house prices. Fiadwo et al. (2007), found after examining the relationship between socio-economic and demographic factors and housing quality indicators in Ghana that income appears to be the principal determinant of housing quality. Research on housing throughout the world indicates that the development pattern of housing shows similarities and appears to go hand-in hand with the socio-economic development in countries: the lower the income level, the more limits to the capabilities and the poorer the quality of the dwelling (Egmond, 1999).

Design and Engineering Problems in Social Housing

Tipple and Korboe (1998), argue that design and engineering solutions in social housing are divorced from the actual socio-cultural values of the households, suggesting that they are 'context-blind'. In many cases the used designs and building systems fail to meet or support the requirements of residents in an effective and meaningful way. No proper consideration appeared to be given to the particular contextual environment (ADB, 2003). It refers to the particular circumstances of the natural, often hazardous environment as well as the socio-cultural and economic environment. It extends to include constraints on design solutions imposed by outmoded building regulations inherited from colonial rulers which most obviously do not fit the local conditions and household needs and requirements. The prevailing standards, codes and regulations are mentioned to harm a sustainable social performance of buildings. Instead design and engineering solutions must take into account the peculiar characteristics of the households, rather than through the imposition of (sometimes alien) market-oriented value systems (Tipple and Korboe, 1998).

Extra room for home based enterprises and activities as well as the need for adaptability to enable the communities to re-arrange the house plan related to their generation of income are essential whilst these contribute to a sustainable livelihood in DCs (Septanti, 2000; Tipple, et.al, 2002; Silas, 2003). However many houses for LIHs are small and characteristically inflexible (Yap & Walander, 2010). The spatial configuration lacks both variety and the capacity to accommodate post-occupancy changes (Wong, 2010).

The problem is thought to arise because in mass housing programs, as a prerequisite for efficient operation and production processes, requirements are often 'normalised' to produce 'standardized' 'one-size-fit-all' design solutions (Habraken, 1975). Moreover most buildings are designed to satisfy existing forms of use, rarely designed to meet future requirements (Gan and Barlow, 1996; Durmisevic, 2006). No consideration is given to the fact that "The household life cycle and labor market career, condition the development or maintenance of certain patterns of values, norms, and attitudes that, in turn, affect the formation of an aspiration picture of the household's residential situation" (Priemus, 1986). This human dimension, the diversity of needs and priorities of households, as a result of differences in stability and sources of income, saving-capacity, and differing phases in the family cycle require adaptable house designs (Breddnoord & van Lindert, 2010).

The rigid plans unwittingly also introduce some form of built-in obsolescence (Kronenborg, 2007). Over time, the mismatch between the less mutable attributes of the design and building systems and the changing requirements of users reduce the 'practical usability' or functionality of the building. This widens the gap between the desired level of quality and the physical quality of the building as defined by its attributes (fig. 1). The buildings become functionally obsolete, users are dissatisfied

and the building may be abandoned. The deficit in functional performance leads to the observed shortfall in the lifespan of buildings, which have shortened from a technical (designed) life of about 100 years to a functional (use/economic) life between 20 and 35 years (Duffy, 1990; Kendall and Teicher, 2000; Lichtenberg, 2006). There is loss of return on investment and in the case of mass public houses make it difficult to maintain existing stock or to develop new units. Thus spatial arrangements should be *adaptable and flexible* to cater for the diverse and changing needs of the households. In contrast households are *generally assumed* to stick to long-established usages and habitual patterns, with slight changes during the lifespan of the household. The designs fail to serve intended purposes and become less functional, because the goals, aspirations and perceptions of the user and designer on quality often conflict.
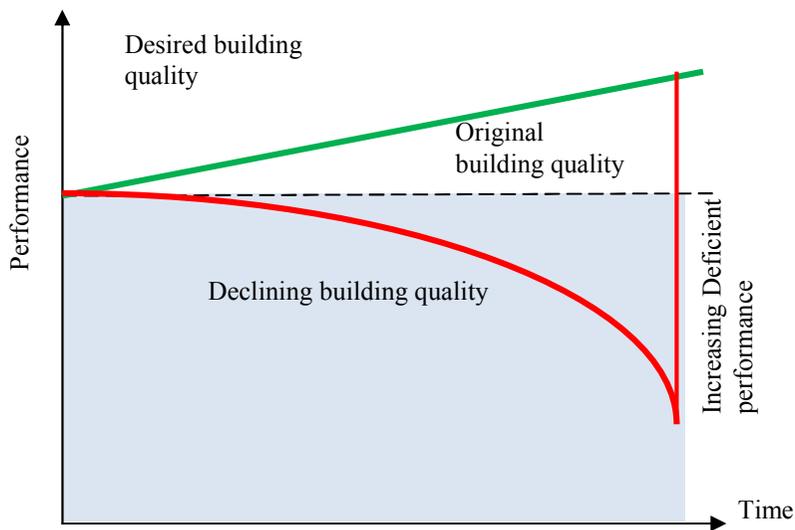
Figure 2. Quality Deficit in the Life of a Building

Response to Failing House Design and Engineering Solutions

The traditional response to the failures in meeting the demands and challenges for functionality and adaptability of a dwelling has been largely through maintenance and retrofitting of the buildings in different forms on different scales. According to Douglas (2002), though useful, this is marginal in effect when balanced against associated technical difficulties, the effect on the building fabric as well as the implications for life cycle costs and waste generation.

Beyond maintenance and retrofitting, service life planning techniques namely the Factor Method and Engineering Method (ISO 15686-1:2000) have also been advocated. These methods focus on the durability of building. They presume that by selecting materials, components and systems of a building based on an estimated service life, along planned maintenance, it is possible to reduce the rate of physical

deterioration of buildings, taking into account certain factors considered critical to performance over time. The major criticisms are that these are theoretical constructs (Kohler and Hassler, 2002), utopian in nature and associated with practical difficulties for application (Hovde and Moser, 2004). Aikivuori (1999) further argues that the critical loss of performance in buildings what fails before durability is the 'perceived quality of the building'. Thus, beyond decay and durability based models, there is the need for functionality-based approaches that put the human dimension at the centre point in order to enhance the lifespan performance of buildings. In this respect an approach towards more open design solutions that can be used in ways brought up by the user rather than by the architect and not directed for a single defined use becomes useful.

The immense importance of the design of dwelling space and selection of the building system on the quality of a house is therefore emphasized. (Swenarton, 2009). In the success story of the Million Houses Program in Sri Lanka, the design strategy and selection of the applied building technology was participatory. This resulted in houses which were cheaper and better suited to the needs of occupants (Sirivardana, 1986). In Hong Kong, a strategy called 'Design for Tenant Fit-Out' has been reported for mass public housing (Sulliven and Chen, 1997). The open plan design strategy allows individual families not only to fine tune layouts according to their specific needs, but to build incrementally according to their resource capa- bilities. Such an approach enhances functionality while being affordable. In the case of self-help in Bangkok, the houses were actually designed to be transformable being developed incrementally by the occupants (Yap & Wandeler, 2010). In a study of housing extensions and transformations in Ghana, Zimbabwe, Bangladesh and Egypt, it was found that not only do users seek opportunities to alter their dwellings but that creating possibilities for transformations in houses contribute to increasing habitable space in terms of floor area and number of rooms, and consequently reduces occupancy rates without the need for new-builds (Tipple & Korboe, 1994; Tipple, 1996). A number of governments of DCs now seek to exploit the potential of self-help housing strategies. According to UN-Habitat (2005), "assisted self-help housing is the most affordable and intelligent way of providing sustainable shelter' because it is cheap, useful, practical and flexible, able to expand over time and thus to a large extent sustainable.

CONCLUSIONS

Findings of literature studies indicate that the design strategy and building technology solutions do need to take the human dimensions into consideration to make dwellings adaptable and affordable or not. To be sustainable housing solutions must be evidence-based. This means they must be informed by 'context-relevant scientific knowledge' (Kohler and Hassler, 2002), on the factual needs of the inhabitants and the available and applicable capabilities in terms of finite natural resources (energy, materials, water) and the human capabilities (knowledge, skills, rules, regulations and conventions) for the development, diffusion, acquisition,

adoption, and implementation of technologies and knowledge in sustainable residential construction (egmond, 2009).

Although studies on functional, adaptable and affordable housing solutions have been carried out in many developed countries (e.g. Kendall's Open Building), their applicability in a developing world context is yet to be tested. This is also true for the numerous Post Occupancy Evaluation studies which have been carried out in the developed world.

It is not yet known how the response to the social housing problems in DCs from a design and construction point of view contributes to meeting the goals of sustainable housing. I.e. the extent to which the different spatio-physical attributes of the dwelling spaces in DCs meet or support user lifestyle and domestic activities in both the short- and long-term is un-clear.

It is not known to which extend particular building systems and spatial arrangements in house designs in DCs allow any adaptations for a better fit to the household activities at a certain stage of the household life cycle and labor market career. Also is not known to which extend the households are able to cope with the boundaries of the spatial arrangement in the house designs.

Further research is needed to contribute to filling the gaps in knowledge and understanding on the above mentioned aspects. Research onto the human dimension in design and engineering solutions for sustainable housing of the LIHs in DCs is evident. After all, residential construction involves man at the demand side as well as at the supply side of the houses. Methodologically the need is recognized to integrate engineering approaches with concern for human aspects in order to produce artifacts that are context-relevant and which meet user requirements, since a majority of research in construction has tended to focus on technological issues being divorced from user demands (Carroll and Rosson, 2007).

It is suggested that the so-called Technology Mapping Method should be merged with Needs Assessment Methods to integrate the Human dimension in the studies. The Technology Mapping Method has been developed to assess the available and applicable natural and human capabilities for housing provision (Egmond, 1999). With the research findings strategies and building decisions can be made with regards to alternative design solutions which meet demand of the LIHs in DCs in terms of functionality, adaptability and affordability that contribute to sustainable housing particularly for LIHs in DCs faced with an immense housing shortage and hazardous natural circumstances.

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