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COMPRESSED EARTH BLOCK (CEB) TECHNOLOGY IN SELF-HELP HOUSING:

A Potential Solution to Affordable Housing Crisis in sub-Saharan Africa?

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COMPRESSED EARTH BLOCK (CEB) TECHNOLOGY IN SELF-HELP HOUSING:

A Potential Solution to Affordable Housing Crisis in sub-Saharan Africa?

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ABSTRACT

The 2030 Sustainable development Goals set by the United Nations to address living conditions in developing countries of Africa, Latin America, and Asia, aspires to ensure adequate access to affordable housing, basic services, and the upgrading of slums. This paper focuses mainly on the issue of affordable housing in sub-Saharan Africa, which is often associated with a series of underlying factors ranging from the increasing rate of urban growth and population, as well as, an increasing rate in poverty and unemployment. The literature highlights other problems linked to housing in sub-Saharan Africa such as the scarce availability of resources, high cost of building materials, a large proportion of illegal settlers, heterogeneous physical housing stock, insecurity of tenure rights, bureaucratic incompetence, and inaccessible mortgage mechanisms for the poor.

The paper explores the role of self-help housing in the provision of affordable housing in sub-Saharan Africa by investigating a building technology known as Compressed Earth Block (CEB). The technology represents an evolution of the adobe bricks by using a mechanical device to compress the earth inside a mold, producing blocks in standard sizes with similar performances in terms of load-bearing capacity, durability and freedom from maintenance as adobe. In addition, CEB provides a sustainable technique which could serve as an alternative to other conventional building materials such as concrete cement and steel in the provision of low-cost housing.

To investigate the feasibility of integrating CEB technology into self-help housing, the paper analyzes 3 case studies of self-help housing in the '90s that incorporated the site and service approach in establishing self-help houses. The 4 factors considered to be key requirements of merging the CEB technology into self-help housing include security of tenure; affordability; capacity of individuals, households, and resident groups; and sustainability in social organization.

Keywords: Self-help housing, Compressed Earth Block (CEB] technology, Sustainable housing and urban development.

1.0. INTRODUCTION

Compressed earth block technology creates a platform for connecting the idea of ‘self-help’ to affordable housing crisis in sub-Saharan African countries. It provides a sustainable form of development, through a balance of the environmental, economic, and social aspects of housing.

The quest for affordable housing in sub-Saharan Africa is yet to be proven a success. The United Nations projects 90 percent of urban growth by 2030 to take place in Africa, Asia, Latin-America, and the Caribbean. On this note, the 2030 Sustainable Development Goals (SDGs) aspires to ensure access not only to affordable housing, but also basic services and the upgrading of slums. The failures of the past could be attributed to the excessive focus on Internationalism and the elimination of self-help housing in trying to gentrify cities through economic revitalization. Whether that is true or not, is subject to a debate but we would rather focus on the future by learning from the mistakes of the past.

The phrase “Think globally, act locally” is attributed to the famous town planner, Patrick Geddes who introduced the concept of “region” to architecture and planning. This idea urges people to consider the health of the entire planet and act in their communities. This introduces the notion of sustainability, which is yet to be achieved in the housing development of developing countries, most especially in Sub-Saharan Africa.

Compressed earth block technology represents an evolution of the adobe bricks by using a mechanical device to compress the earth inside a mold, producing blocks in standard sizes with similar performances in terms of load-bearing capacity, durability and freedom from maintenance

as adobe. On the other hand, the concept of self-help housing refers to the contribution of individuals in building unplanned housing units without application of the existing planning and design regulations, often discovered in informal areas without any government interventions. The concept provides a use and exchange value to its inhabitants, as well as, a useful tool in conflict resolution if it incorporates a good leadership scheme which could help built better inter-communal relationships through community participation in the building process.

John F.C. Turner who studied and observed self-help settlements in several developing countries in the 1960s found that households improved their settlements incrementally, using better materials and adding space over a period of 15years. Compressed earth block technology provides a sustainable technique which could serve as an alternative to other conventional building materials such as concrete cement and steel in the provision of low-cost housing, through its integration in the concept of self-help housing. More so, the technology if sustainably developed into other financial sectors, serve a means of creating employment opportunities, in turn, reinforcing the alleviation of poverty in sub-Saharan Africa.

2.0. LITERATURE REVIEW

2.1. Affordable and Self-Help Housing in Developing Countries, and the Developed World.

In the manual on self-help housing outlined by the United Nations Departments of Economic and Social Affairs, the three (3) main reasons to undertake self-help housing programs include a.) The cost of building even a minimum house is greater than the family can afford or the cost of building enough houses to satisfy the needs is greater than the economy can afford; b.) The labor force in the national building industry is in short supply and all the private and public construction works compete for this labor, resulting in inflationary cost increases and disruption of building programs; and c.) The talents and resources of the people are not being utilized or allowed to contribute to any other national development program. At this point, we can pose that many if not most sub-Saharan African countries fall into this category. In addition, the manual highlights the seven steps that must be realized satisfactorily before a project can be considered a success, in terms of organization of structure: i.) mass construction; ii.) training artisans for the building industry; iii.) working hours; iv.) size of groups; v.) team method; vi.) temporary and core housing; and in terms of design and use of materials: vii.) expandable houses.

In the charter of the United Nations, the international human rights law recognizes that every human possesses the right to an adequate standard of living for himself or herself and his/her family, including adequate food, clothing and housing, and to the continuous improvement of living conditions (OHCHR, 2008). According to the World Health Organization, 1.2 billion people in developing countries lack access to drinking water, and 1.8 billion people live without access to adequate sanitation (WHO Decade Assessment Report, 1990). The World Bank statistics as of 2015 estimated 880 million people living in slums of developing countries, and that 90 percent of

urban growth by 2030 would take place in Africa, Asia, Latin America, and the Caribbean. It projects that 6 out of 10 people would live in urban areas by 2030. The Deputy Executive Director and Assistant Secretary-General for the UN Human Settlements program (UN-Habitat), Aisa Kirabo Kacyira also estimates that “the struggle to obtain adequate and affordable housing could affect at least 1.6 billion people globally” (World Bank, 2016) within the next decade.

The United Nations Human Settlements program compiled a list of characteristics describing slums ranging from the lack of basic services to overcrowded housing, insecure tenure, irregular or informal settlements, unhealthy living conditions, minimum settlement size, and substandard housing structures, even so, high levels of poverty and social exclusion. All of these highlighted characteristics were based on a review of definitions used by local governments and other institutions in dealing with slum issues and public perception (UNHSP, 2003), and current research only unveils that slums rarely meet minimum standard of ‘adequate housing’ (Westendorff, n.d.), while the fact still remains that about 43 percent of urbanities or somewhat 870 million people in developing countries live in slums (UN Habitat, 2003). Westendorff (n.d.) argues that these figures suggest at least four of every ten urban residents in developing countries lives in self-built housing that in one aspect or another appears to be inadequate, in other words, exposed to physical conditions that are known to be harmful to human beings. More so, UNHSP concludes based on the urban growth rates and declining rates of public investment supports for low-income housing that the population of slum dwellers are likely to be growing rather than remain stable or declining, even so, worsening conditions in the presence of globalization that reduces the supply of formal sector employment and tightens the belt around redistributive mechanisms. Hence, self-help/self-built housing has the potential to fulfill a range of societal functions (Westendorff, n.d.).

The 2030s Sustainable Development Goals (SDGs) target to ensure access to adequate, safe, and affordable housing and basic services and upgrade slums, and one of the goals aims to “make cities and human settlements inclusive, safe, resilient, and sustainable”. The inclusion to upgrade slums and the figures illustrated above demonstrate that past methods of urban revitalization towards sustainable low-cost development failed. Cedric (2001) blames the failure and problems of the 1980s and 1990s economic crisis in Sub-Saharan Africa and Latin America, on governments elimination of self-help housing in trying to gentrify cities through economic revitalization. This can be associated with the fact that present developing countries have produced higher rates and volumes of demographic growth, even so, because of earlier ages in marriage and improved health. According to Buckley, et. Al, (2005), John F.C. Turner argues that self-help housing in providing only basic shelter and services, allowed poor families to expand their units over time as their savings and resources permitted, and to use their own labor to maintain and increase their wealth. This argument follows some points that would be further discussed in the paper.

The concept of sustainability has an economic, environmental, and social aspects to it. Urban development often focuses on the economic while ignoring the environmental, and social effects on the vulnerable populations in the society (Allison, 2007). Dr. Joan Clos, the executive director of the UN-Habitat in 2017 said ensuring housing affordability is a complex issue of strategic importance for development, social peace, and equality. Clos added that 1.6 billion people live in inadequate housing, of which a million live in slums and other forms of informal settlements. The unaffordability of housing has led to an increasing number of people residing in slums and other divided parts of the city, as in ‘ghetto neighborhoods’ in the American context. The spatial inequality is first related to social inequality (Musterd, 1999). A lot of developing

countries are eliminating slums to replace them with gated communities, from overcrowding to sprawl, and from homelessness to vacant houses, which proves that housing is shaping cities worldwide, unfortunately, producing spatial and social inequalities. A report from the World poverty clock released in June of 2018 shows that 7 of the top 10 countries with leading poverty population are from Africa, with Nigeria currently topping the list with an approximate 90 million, and Uganda being number 10 with another 14.2 million people living in extreme poverty (Quartz Africa, 2018).

Poverty refers to the scarcity of a certain amount of material possessions or money. The effect of this is an increased marginalization, and increased poverty of the poor as evident in many developing sub-Saharan African countries (Allison, 2007). In many countries, including governments and non-governmental organizations (NGOs) the issue of low-cost housing has become a major focus to provide suitable housing for low-income groups through various policies and programs. Abd-Elkawy, A.A.M. (2017) points out that self-help housing is one of the few programs that meet the actual needs of the population within the framework of appropriate support from the state. The concept of self-help housing is not new, but its definition could be perceived as varying from place to place according to the role of population and the government in providing housing units, as well as the application ratio of planning and design standards in the construction process (Abd-Elkawy, A.A.M. 2017).

John F.C. Turner who studied and observed self-help settlements in several developing countries in the 1960s found that households improved their settlements incrementally, using better materials and adding space over a period of 15 years. He argued that self-help incrementalism was much better than centralized public housing in terms of affordability, flexibility, and human creativity in seeking value in life (Pugh, 2001). Dr. Clos in his commemoration speech on the UN-

Habitat day of 2017, discussed the need to promote inclusive housing and social services that include a safe and healthy living environment with consideration of the vulnerable population in terms of affordable and sustainable transport and energy, and job creation. The sustainable development goals (SDGs), targets to create better cities and sustainable settlements by ensuring success of adequate housing, even so, upgrade slums. The inclusive approach to providing housing and strategy to upgrade slums only proves that the United Nations has realized the social effects of harsh economic development strategies on the poor and low-income individuals residing in informal settlements.

The current state of developing countries might make it seem quite difficult to implement economic development plans, and the reason for failure in the quest to produce affordable housing but it is more because of urban bias as discussed by Lipton (1977), whereby development is impeded by groups who by their central location in urban areas pressure governments to protect their interests. The concept of Urban bias, as argued by Lipton (1997) shows that the discrimination against agricultural practices and focus on Industrialized labor is a causative for retarded development- in extreme favor of foreign trade and domestic capital exploitation. Industrial developments are being favored at the opportunity costs of agriculture, thereby leading to an increased rural-urban migration because of inadequate social services, including housing. Allison (2007) explained this as the case in the post-apartheid era of South-Africa, where the financial constraints laid upon the transportation costs of low-income individuals to where jobs are located forced them to move closer to the urban area thereby causing an increasing demand for affordable housing. The lack of supply on the market, therefore, leads to a choice of settling for informal settlements- slums and squatter settlements.

Abd-Elkawy, A.A.M. (2017) defines on one hand the concept of self-help housing as employed in South Africa when population reuse old buildings and make them suitable for residential purposes by implementing some modifications under the license of the state, after taking series of construction training to build efficient houses, although lacking planning and design requirements. On the other hand, the traditional self-help housing term refers to the contribution of individuals in building unplanned housing units without application of the existing planning and design regulations, often discovered in informal areas without any government interventions. Abd-Elkawy (2017) also points out that the concept of self-help should not be mistaken for that of self-build, which focuses on the stage of building only without participation in the other processes such as design, planning, and management.

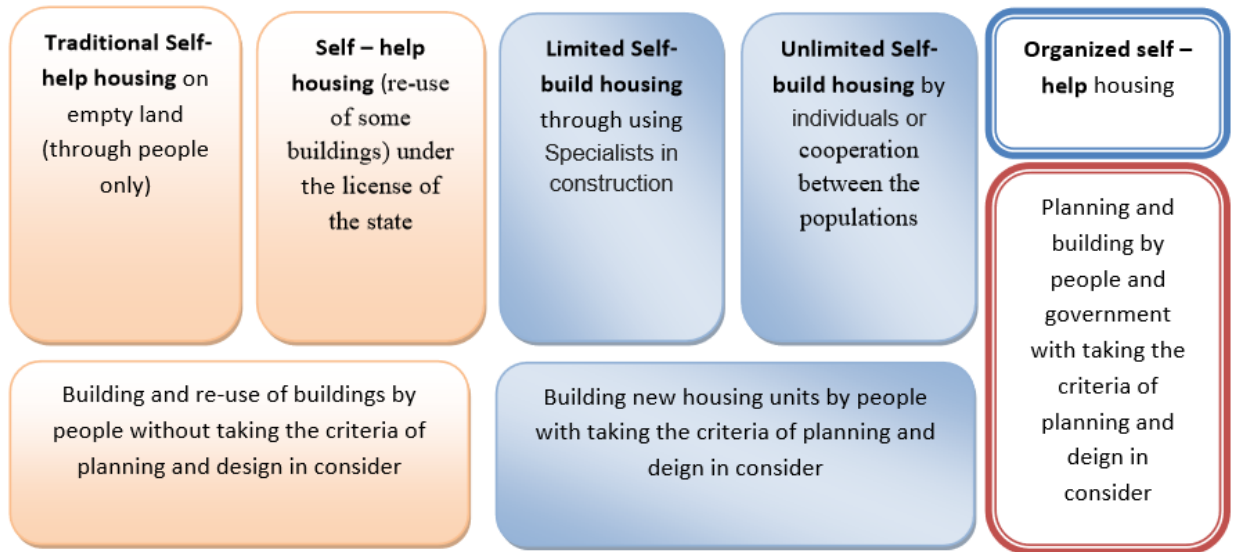


Figure 1- Terms of self-help housing approach according to the degree of legislative and regulatory framework commitment in the building process. (Source: Abd-Elkawy, A.A.M. 2017)

In addition, the concept of the informal settlements is not a new phenomenon as was the case in other developed countries while they were in their earlier phases of development. For instance, the ‘gecekonu’ was a reaction to the housing constraints of lower-income individuals in Turkey (Deniz, 1996), as is the case of ‘hukou’ in China (Chen et. Al, 2011). This is caused by an

inelasticity of supply, which cannot meet the demand on the Housing market. The need for an adequate standard of living, including decent housing as required by the United Nations affects economic development, with the possibility of impacting employment, investment, and labor productivity (Harris et. al, 2006). The strategy of implementing self-help housing on the market could be a solution to the rising issue of housing affordability, and the creation of wealth.

In developed countries, real estate developers are making money from housing developments, with a strong profit orientation. This can be tied to the concept of privatization introduced into the housing market, although it has been successful in countries like Chile, Turkey, Sri Lanka, even so, in the case of Singapore, a source of wealth for its population (Cedric, 2001). Cedric argues that these countries practiced an ‘unorthodox approach’, of which its principle involved a long-term strategic plan and approach. Taking a look at the Singapore economy, it might be okay to pose that the shift towards a market-oriented urban housing initially increased the social and financial costs for the low-income population, but Phang (2001) proves that the integration of the housing finance sector with the rest of the financial sectors undoubtedly improved the economy in a long-run, and increase the wealth of the population.

The standard of living of humans refers to the level of wealth, comfort, goods and necessities available to a certain socioeconomic class in a geographic region. It is not wrong to say therefore that housing could be a source of generating wealth. The World Bank became a major player in the provision of housing in the 1970s when it then acknowledged the economic significance of housing in development. In other words, the case of Singapore is one to learn from even though it was criticized for its laws that forced housing beneficiaries to save money in a Central Provident Fund (CPF). Phang, 2001, argues that this was not just an instrument for ensuring payback on loans but a form of social security scheme that ensured beneficiaries to

generate wealth for themselves in their old age. If we compare this idea with that of John F.C. Turner, then an argument could be posed that his concept of self-help housing with a similar scheme to the CPF is one principle that could be implemented in restructuring the housing market in developing countries.

In the past, implementation of the self-help housing approach practiced faced challenges such as the high cost of construction and lack of adequate expertise, which were addressed through government supported policies like site and services, including core housing for developing informal or new areas. On the other hand, the decline of financial government support at the international level during the 1970s led countries to realize new mechanisms like providing cheap land for low-income people with financial support from private sector and banks to implement the concept of self-help in housing without the financial burden on the state, and completing the residential areas in short time (Abd-Elkawy, A.A.M. 2017). Also, government intervention did not apply until the 1970s and 1980s to develop existing informal residential areas with the provision of infrastructure and services. Since the 1970s there has been an increasing consensus that while self-help housing offers use value to its resident and users, it also provides an exchange value that it commands were it to be sold (Ward & Macoloo, 1992). This reinforces housing as a commodity which is valorized according to the mode of production of which it forms an integral part.

Privatization in developed countries has been criticized for its use of laws like eminent domain and forced eviction which raises the discussion of social and spatial inequalities from residential segregation, decentralization, and increased unemployment, as observed in Central-East European countries (Natasha, 1994). In the case of Singapore, the draconian land acquisition act of 1966 which abolished the provision of land through eminent domain was a huge contributor to its success (Phang, 2001) unlike what is practiced in the United States. More so, the awarding

of contracts through an ‘open-tender system’ helped the public sector manage the demand control in the housing market. The CPF scheme encouraged increased competition and incentives to work that in turn, resulted in an export-driven economy. To bridge the gap of social inequality from growth, the government policies spread the benefits to low-income individuals through other scholarship and grant scheme, including education schemes and annual regressive tax benefits. At this point, we draw closer to the quest for sustainable whole-sector developments that integrate the economic, environmental, and social aspects of humans (Pugh, 2001).

In Tosics (2004) explanation of a sustainable urban development indicates a relationship between policies such as governance, finance and taxation, public administration, and a comprehensive urban development policy. He argues from his study of housing and sustainable urban development in European cities that sectoral policies in respect to housing management and maintenance, transport, infrastructure development, as well as commercial and trade sector development policies are vital for sustainable development. As seen in the case of China, ignoring the transportation sector led to congestion in urban cities, which made Yang, and Gakenheimer, (2007) recommend that; 1.) suburban localities should retain high densities, 2.) development should be clustered, and 3.) a provision of local service centers to keep up with housing activities, as these would help control sprawl and reduce demand for housing in urban areas.

Altmann (1982) argues that to date housing policies and administration procedures in developing countries would find it difficult to cope with the needs and desires of squatting populations, even when they seek to do so as a result of insufficiency in time; personnel; material and immaterial resources; and capacities. In addition, he claims that plan implementation often proves to be less successful due to a lack of capacity or competence in the executive agencies, thereby leaving these unsolved problems to invite spontaneous self-help by the concerned

population. He characterizes the terms ‘self-reliance’ and ‘self-determination’ as twin concepts which do not only apply on a national scale but also, the local level of individual citizens, pointing out the potential for self-organization of the squatting population groups (low-income and urban poor) if the following factors were dealt with comprehensively: a.) legalization, b.) flexible, planning, c.) lowest standards, d.) internal resettlement,, e.) minimum formal organization structure, f.) on-site authorities, g.) low-level partners, h.) financing conditions, and i.) local technical service off. Altmann argues that the significance of the squatter population strata must not be underestimated since their proportion outnumbered that of the non-squatters of many cities in developing countries averaging about 30-60% of the overall population of developing countries. Merely taking a look at the set of important requirements for successful organized self-help housing program as highlighted by Abd-Elkawy, A.A.M. (2017) in the figure below, there appears to be a conflict with the self-help school of thought which presents tenure security as the prime requirement for self-help housing, as well as, one of the major causative for the lack of affordable housing. Also, there is the question of why the participation of private sector is seen to be a priority in pursuit of a successful self-help housing project. Otherwise, other factors highlighted might be vital when addressing the affordability in terms of material, construction, and financing.

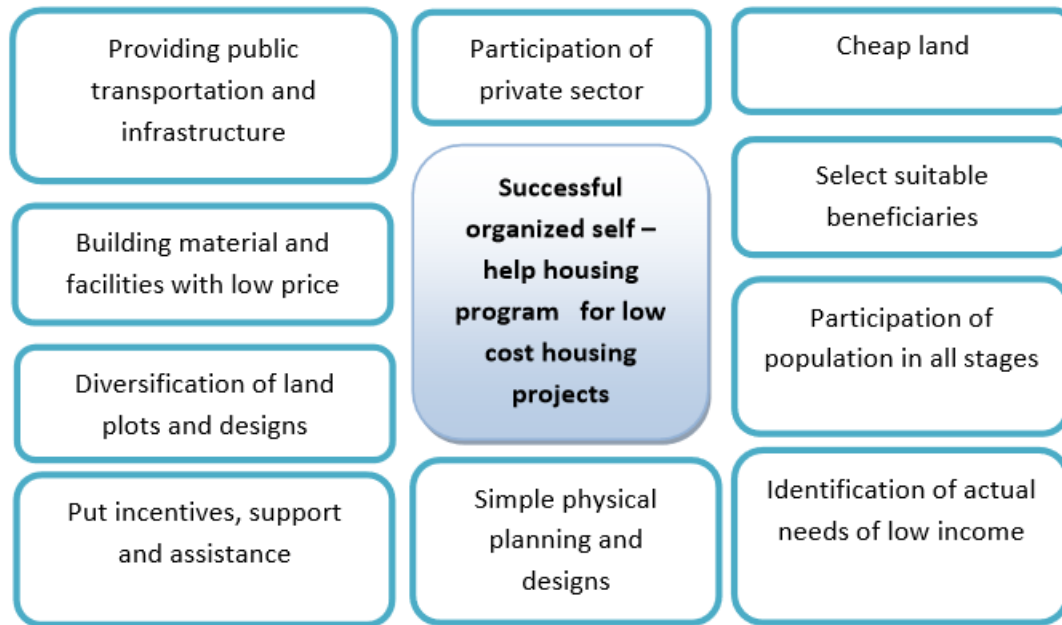


Figure 2- Main requirements for successful organized self-help housing program. (Source: Abd-Elkawy, A.A.M. 2017)

The result of inadequate and unaffordable housing in developing countries, especially sub-Saharan Africa, has led to an increasing population living in slums and other forms of informal settlements. According to the United Nations Department of Economic and Social Affairs, this is because of insecurity in land tenure rights, high cost of building materials, inaccessible mortgage mechanisms for the poor, and high rents in urban settlements. The increased volume of populations in developing countries of sub-Saharan Africa, and insufficient savings and investments cannot be ignored when exploring the issue of affordable housing. Pugh (2001) estimated that self-help housing constitutes 30-70% of the housing stock in developing countries. That number is increasing in recent years, and for that reason presents the argument to why informal settlements should not and cannot be ignored or otherwise threatened when strategizing for urban development, as this would just result in an endless race to fight poverty in developing countries. The concept of self-help and self-build settlements is a trend that has been in practice since the 1950s and 1960s.

UNDES (1964) pointed that in order to realize the potentials of self-help and reach the targets of the then development decade, other steps taken should include instituting development planning, vocational training in the construction/building industry, an inflow of capital, and utilizing the vast latent human resources of the developing countries. UNDES argues that this would double the contribution of housing to the national income, present a major effect on the gross national product, and open the market for local materials that would not otherwise be used, which might even have a stabilizing effect on inflationary trends. Also, the valued low-cost of the housing may be able to cause families to place more savings in local banks, hence accumulation of wealth. More so, a maximum contribution approach made by families who want to solve their housing problems aims at reaching a goal that is in harmony with the United Nations conception of human involvement/participation as a precondition for achieving the aims of the development decade.

The World Bank also showed interest in such a concept of ‘learning by doing’ as in the 1970s Kampung Improvement Program (KIP) it invested in Indonesia. The project aimed to achieve a sustained improvement, which it did through included benefits such as upgraded living conditions in terms of health, income and poverty reduction, and access to infrastructure (Pugh, 2001). The concept helps build better community participation and the allocation of tenure rights, that in the long run help encourage beneficiaries to invest over time in their settlements. The experience in Indonesia was critiqued for its lack of hedonic indices- in understanding the behavior of its residents in the market, and lack of engagement by women, a major problem in many developing countries, especially in sub-Saharan Africa, that discriminate against women’s ownership rights and involvement in the labor sector. The Orangi model in Pakistan also centered on the use of affordable technology and resource allocation in water and sanitary services, thereby

bringing health and economic benefits, including an increased investment in housing projects, and connection to citywide networks (Pugh, 2001). Self-help housing concept could be a useful tool in conflict resolution if it incorporates a good leadership scheme, which would, in turn, build better inter-communal relationships through community partnership and participation.

More so, self-help could succeed in empowering poor people through the positive effects of community groups and nongovernmental organizations (NGOs) in the pursuit of poverty reduction. Although, the lack of a proper archiving system for land allocations and statistical data in sub-Saharan African countries could be a constraint in this development. Providing secure tenure through property rights to residential properties would help unlock the dead capital in communities (Buckley and Kalarickal, 2005), which is associated to the latent resources, including creativity of humans to perform labor that yield economic value. This should involve a legal binding of the right of access to property ownership by women. The concept of self-help housing would help maintain regularity in the housing market demand over time, including a genuine involvement of low-income and poor families in the generation of wealth, and counterproductive effects of rent control on the functioning of the housing market (Buckley and Kalarickal, 2005).

Furthermore, there is a need for comprehensive planning, as well as, administrative organization and training with a basic team. The basic unit of activity in a self-help organization is the group, either as a family or operating as an artificial team. According to Westendorff (n.d.) volunteer roles and actors in self-help housing takes five forms which include spontaneous individual process; facilitated individual process; facilitated collective process; comprehensively assisted and organized collective process; and comprehensive mutual-assistance cooperative. In a superficial review of some of the constraints to self-help housing, Westendorff (n.d.) makes note of four broadly major factors of adequate housing namely: affordability, livability, security, and

sustainability. Bredenoord, & Lindert (2010) point out that the self-help school considers housing security as the prime requirement for the success of self-help housing projects.

The concept of self-help housing is feasible in the provision of affordable building materials, thereby strengthening the arguments of John F.C. Turner, and creating a room for my argument of compressed earth block (CEB) technology as an alternative building material for the provision of affordable housing in sub-Saharan African countries. The housing problem in developing countries can be associated with a large proportion of illegal settlers, a heterogeneous physical stock, and diverse tenure dispositions (Lim, 1987). To encourage the development of affordable and homogenous physical housing stock, my research would investigate the potential of compressed earth block in the provision of affordable housing in sub-Saharan African countries. Aside from its potential as a means of construction, I believe it has a role to play in the pursuit of peaceful empowerment through community participation, and wealth creation through economic development strategies in a whole-sector development technique. This would help place 'housing at the center' of urban development, as advocated by the United Nations in its 2017 habitat agenda.

Finally, Bredenoord, & Lindert (2010) argue that while most families have low to very low-income, their governments often focus on solving housing problems of the middle classes, hence, further increasing the huge gap between the supply and demand for affordable housing in developing countries. They argue in their quantitative importance of informal housing supply that; "the evident failure of both exclusively state and exclusively market provision approaches, leaves no alternative to self-help solutions at least as a complementary measure to other programs" (Mathey, 1992). In conclusion, they claim that in view of the immediate future housing demand, amid the urgent housing needs, governments must pay attention to the power factor that self-help housing can be:

“... the most affordable and intelligent way of providing sustainable shelter. It is cheap because it is based on minimum standards and incorporates a substantive amount of sweat equity. It is useful because individuals and communities engaged in it acquire precious skills. It is practical because it responds to people’s actual needs and levels of affordability. It is flexible because the dwelling units are often designed to be able to expand over time. But all construction, and particularly incremental upgrading requires a suitable supply of building materials, components, and fittings” (*UN-Habitat, 2005*)

2.2. Earth Construction

The compressed earth block (CEB) is an alternative to the existing conventional construction materials used in housing development. The technology could serve as a better sustainable form of construction because of its availability in sub-Saharan African countries as compared to the other scarce and expensive materials, which could potentially make housing construction cheaper in the long-run. In discussing CEB as a potential for affordable housing creation in developing countries, there is a need to review its history and literature as it relates to the concept of Earth architecture.

Earth is one of the world’s most locally abundant, cheapest, and lowest impact building materials. Archeological evidence according to Harris (2017) proves that entire cities have been built with earth, as in the case of Jericho, and Babylon, over 10,000 years old. The Great Wall of China that incorporates elements of rammed earth, was begun over 5,000 years ago (Harris, 2017). Other ancient cities built of earth include dwellings found in Turkmenistan dates from about 8000 and 6000 BC. El-Obeid in Mesopotamia also dates to 5000 BC (Pacheco-Torgal and Jalali, 2012). Earth is not just a forgotten concept of the past, but there is evidence of its use in modern

architecture. The Chapel of Reconciliation built in 2000 in Berlin, Germany was constructed with the use of rammed earth. The Eco House built in the early 90s in Norrkoping, Sweden was constructed using mud bricks. Also, the Handmade School in Bangladesh incorporated an improved tradition of the Cob culture in earth construction (Sameh, 2014). Earth construction has increased substantially in the US, Brazil, and Australia due to the sustainable construction agenda, in which earth construction assumes a key role (Pacheco-Torgal and Jalali, 2012). This supports the United Nations sustainable development goals (SDGs) that seek to ensure access to adequate and affordable housing by 2030, as discussed earlier in this paper.

There are several methods of implementing earth construction, which include: wattle and daub; mud brick; rammed earth; compressed earth block (CEB); and other techniques either hand-made or mechanically made (Sameh, 2014). The wattle and daub technique involve pressing the earth against a woven lattice of wooden strips used for about 6000 years and is like the Portuguese technique ‘tabique’. On the other hand, the cob technique involves mixing earth with straw and water to form walls in step of layers (Pacheco-Torgal and Jalali, 2012). The rammed earth technique requires compressing a damp mixture of sand, gravel, and clay while adding a stabilizer material such as lime. The mud brick technique is maybe the most popular and requires mixing sand, clay, water and other organic material such as straw, dung or sticks before shaping the mixture in blocks and left to dry naturally for about 25 days (Sameh, 2014). The compressed earth block (CEB) represents an evolution of the adobe bricks by using a mechanical device to compress the earth inside a mold (Pacheco-Torgal and Jalali, 2012), to produce blocks in standard sizes and similar performance as the adobe bricks or blocks in terms of load-bearing capacity, durability, and freedom from maintenance (Harris, 2017). The CEB technology is like the rammed earth

technique as they share properties in the use of a small amount of lime or cement to improve stability and resistance to moisture.

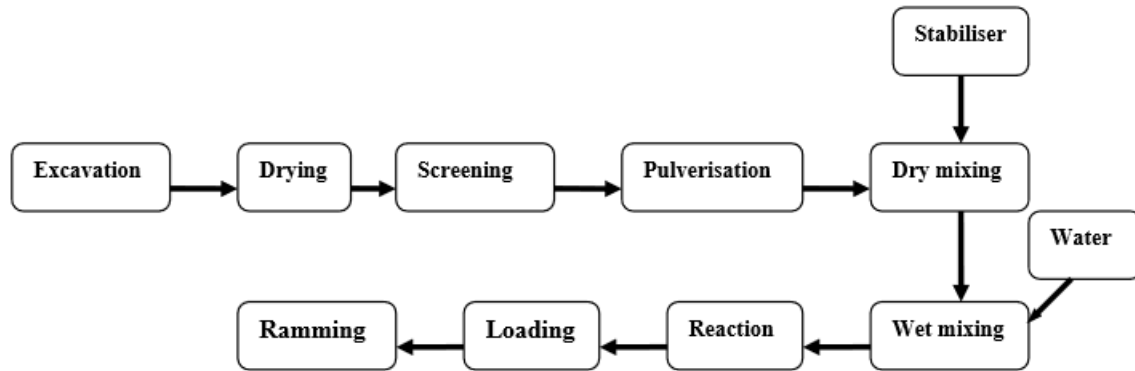


Figure 3- Production process of rammed earth. (Source: Zami and Lee, 2009)

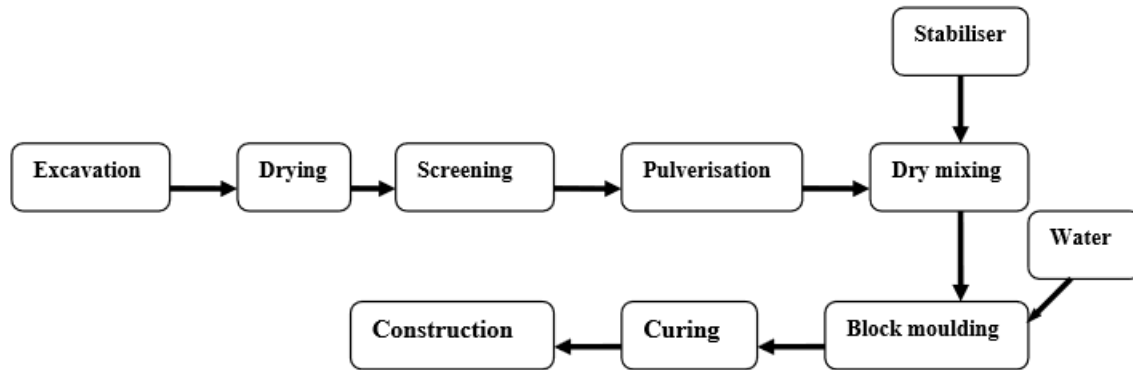


Figure 4- Production process of compressed earth block [CEB]. (Source: Zami and Lee, 2009)

Pacheco-Torgal and Jalali (2012) argue that 50% of the world’s population live in earth-based dwellings, and if these dwellings had been built in modern materials like aluminum or concrete, we would have been far closer to a global ecological breakdown (Zami and Lee, 2009). According to Pacheco-Torgal and Jalali, 2012, over the next 20 years, China will need over 40 billion square meters of combined residential and commercial floor space. The industry, environmentally speaking, accounts for 30% of China’s carbon dioxide emissions, in addition to the other consumed raw materials which clearly shows an unsustainable industry contributing to

climate change. As earlier discussed in the literature, the United Nations projects the fastest growth in populations over the next decade to occur in Africa because of the rapidly changing demographics. This would further increase the consumption of non-renewable materials, as well as waste production, and therefore there is a need to promote the use of more sustainable construction materials within the construction industry and help contribute to the eco-efficiency and sustainable developments within the industry (Pacheco-Torgal and Jalali, 2012).

Earth construction techniques have proven to be a better alternative to the other conventional methods of low-cost housing development for developing countries. Bredenoord (2017) says that the applicability of building materials is determined by the availability of materials; the culture of making building materials; the construction methods; the power of individuals, households and residents' groups; and the willingness of entrepreneurs to participate in house construction. Merely looking at the first criteria on the list, it is no less than obvious that the use of scarce and expensive conventional materials like concrete cement, and steel is one of the causatives for failure in the strive for affordable housing in developing countries. Also, to answer the culture of making building materials, history presents to us the successful uses of earth in construction from ancient times up until now. If the power of individuals and willingness of entrepreneurs are addressed, this can create a mechanism for wealth creation and alleviation of poverty through a sustainable expansion in the construction industry.

According to Zami and Lee (2009), buildings are big users of raw materials and the environmental capital locked in them, including the waste footprints is enormous. Also, the environmental damages because of current conventional practices in construction are evident, which calls for addressing the damages in the form of global warming to avoid a future disaster. Earth when used as a building material, is recognized as possessing a few exceptional features for

the realization of sustainable development, and a means to bridge the gap between high income and low-income housing in developing countries (Daniel AA et. Al, 2018). On the contrary, due to modernization people have ignored the cost-effectiveness, durability, and thermal comfort of earth buildings. (Sameh, 2014) also confirms that they provide good sound and thermal insulation, in the sense that they help in regulating indoor humidity. Earth buildings are non-toxic, non-allergenic, and fireproof, thus providing a safe and healthy indoor environment for the inhabitants. More so, they are biodegradable, highly recyclable, and have low embodied energy. If locally sourced on-site, earth-based materials save transportation and fuel costs. Deboucha and Hashim (2011) add that the natural appearance and colors of earth help buildings integrate into the landscape.

Few African countries have comprehensive or effective programs to address the global agenda of sustainability using appropriate construction materials (Zami and Lee, 2009). If a two-bedroom low-cost house needs about three thousand fired clay bricks and Africa needs millions of housing units over the next decade, it is unimaginable how much wood would be required to fabricate all these bricks. Haselau (2013) says that to compare alternative construction methods for low-cost housing, there is a need to consider cost, time, and quality. Hence, we can presume there to be an absence of a clear link between the governments focus on the contribution of housing to poverty alleviation, and the ability of the policy to deliver on these objectives. That said, it brings me to my point of argument for Compressed Earth Block (CEB) as an alternative to low-cost housing, and a means to the alleviation of poverty through self-help housing. Zami and Lee (2009) argue that earth has the uniqueness of manifesting the cultural heritage of any people and encourages the consistent use of the material to maintain and preserve the craftsmanship and cultural heritage embedded in the building itself.

Building with earth blocks requires little or no specialist skills but the process is labor-intensive, and it requires heavy work which could be phased to suit both the weather and availability of helpers (Harris, 2017). Sameh (2014) made known that traditional earth building techniques which are simple and labor intensive could be adapted to the modern self-build form of construction, and its durability and flexibility makes it easily extendable or altered in the future. In poor developing countries where little or no technical background exists and providing trained workers is an issue, participation in the building process will help enhance the relationship between the builder and the building he will occupy (Howard, 2009). In the New Gournia Village of 1946 planned by Egyptian Architect Hassan Fathy, the involvement of the Nubians in designing their houses and their participation in the process from the start made them include their actual needs into the designs, hence, making for buildings that fulfilled their needs and expectations (Sameh, 2014), in turn, increasing the stability of the residents. The design process combined earth architecture and passive design methods.

2.3. Compressed Earth Block Technology

Compressed earth block is a building material also known as pressed earth blocks, made from damp soil compressed mechanically at high pressure to form blocks out of an appropriate mix of dry inorganic subsoil, non-expansive clay and aggregate. The blocks can be stabilized with the use of chemical binders such as Portland cement or hydrated lime. The blocks made with the use of such chemical stabilizers are called compressed stabilized earth blocks (CSEB). The procedure for making CSEB include collecting the soil sample and testing for soil classification; then mixing the sample with appropriate stabilizers if needed, before placing the mix in a mold which is then compressed manually and left to dry or cure for 7 days. A 28-day hardening period

is allowed for the block to reach its maximum strength and become water resistant (Dwellearth, 2016).

2.3.1. Advantages and Disadvantages of CEB

CEB holds several advantages that aid its potential for the provision of affordable housing, which range from its mechanical properties to environmental, economic and social benefits. CEB materials are locally sourced, inexpensive and made from natural materials, thereby saving cost in terms of transportation and labor. This allows for better efficiency when produced on a large-scale. Also, CEBs offer energy savings because of their high thermal mass. It uses a passive system of heating and cooling to naturally regulate the inner temperature and humidity of the building, by absorbing and dissipating heat evenly thereby contributing to the comfort of its inhabitants. More so, they are sustainable and renewable, making their structures environmentally and eco-friendly. They produce less environmental waste and are durable because of their resistance to fire, insect, and water.

Compressed Earth Block technology possesses some advantages with respect to the abundance of bulk raw materials; on-site production, which reduces time and transport costs drastically; low energy and skill requirements, which enables community participation in the process of construction (Zami and Lee, 2010) and design (Sameh, 2014). In addition, the technology is environmentally conscious as regards pollution and deforestation; innovative block designs can enable its use in earthquake-prone areas; and the total construction cost is very affordable, with the requirement of only a small amount of water. The Chitungwiza house made of CEB in Zimbabwe was seen to be meaningful using local labor and the absence of imported materials and sent a positive message to the local communities by creating awareness and

understanding of environmental issues such as air pollution, deforestation, and energy conservation (Zami and Lee, 2014).



Figure 5- Examples of buildings made from compressed earth block [CEB] from Atiak, Uganda. (Source: Author)

The other popular construction materials such as clay, fired bricks, and concrete blocks are of good quality but expensive, energy-intensive, and based on heavy industries (RICS, 2008). Although the loss of strength when saturated with water from rainfall or erosion, and a poor dimensional stability were viewed as drawbacks to the use of CEB, the use of a chemical agent like cement or lime in stabilizing the soil eliminates this weakness significantly. Furthermore, the low energy input in processing and handling soil is an advantage for the implementation of CEB, as it requires only about 1% of the energy required in manufacturing and processing the same volume of cement concrete (Deboucha and Hashim, 2010). RICS (2008) makes known of a test on compressed earth block technology performed by Joseph Arumala that approves its use to construct low-rise housing, much better enhanced with the addition of about 5% of ordinary Portland cement. The result of the buildings is mostly robust and resilient (RICS, 2008), which could serve as a solution to affordable housing in sub-Saharan developing countries, which has often been criticized for not having enough space to sustainably accommodate average families.

On the other hand, CEB might seem to fall short of its preconceived notion as the most sustainable building material when we realize that the equipment used for its production are not made from locally sourced materials. Also, the manufacturing process can be time consuming during the early stages that require examination of the soil for correct mix. They can lack stability if poorly made with inappropriate equipment, and increase carbon emissions when adding materials to help stabilize the blocks thereby negating the environmental benefits (Kalale, 2014).

Furthermore, the CEB technology produces quality blocks from the press with regular shape, increased density and sharp edges which, in turn, increases the technical performance of structures produced. The usage of the blocks is flexible in the sense that they fit into both rural and urban contexts, allowing them to meet diverse needs.

The earth material used in the production of the earth blocks is mostly subsoil, leaving topsoil for agriculture, thereby, sustainably creating employment opportunities for local people in times of civic economic difficulties in the sense that people can continue building shelters for themselves regardless of the political situation of the country (Deboucha and Hashim, 2010). Sanya (2007) proves that compressed earth block is not economically beneficial in the context of a few sub-Saharan African countries like Uganda but ties this argument to the scarce availability of cement as a stabilizer. On that note, I would agree but on the other hand, Sanya fails to explore other cost-effective alternatives to cement as a stabilizer for earth buildings. Those developing countries experienced barriers to earth building such as the need for new legislation, technical training, and public awareness of sustainability through knowledge-sharing (Zami and Lee, 2009). Pacheco-Torgal and Jalali (2012) reports the success of vocational training on earth construction undertaken by CRAterre, comprising of a workshop that had been attended by 11,000 visitors in 4 years. Earth construction is not only dependent on training, but also specific regulations as seen in

Germany, Australia, New Mexico, even so, New Zealand which has one of the most advanced legal regulations on earth construction.

Bredenoord (2017) presents a practical example of integrating CEB to self-help by The National Slum Dwellers Federation of Uganda (NSDFU) and the NGO ACTogether. Both work for and with the urban poor in Uganda to support a project in the city of Jinja that provides training in construction skills to aspirant workers and self-build residents, with the aim of creating incremental housing around the city. They incorporate the use of a savings group in managing NSDFU funds. The training and workshop are available to residents of the community and non-residents who are interested in learning. Also, building materials are sold directly to households who may obtain technical assistance for proper and professional use in self-help construction, with the aim of promoting incremental housing. The combined effort of NSDFU and the NGO ACTogether to make financial opportunities available to interested households encourages a level of community partnership and responsibilities among community members. According to Bredenoord housing research, a household must have a property title in order to get loans from the corporations. Also, the households could obtain credits and build quicker with the aid of building materials and the training facility.

2.3.2. Manufacturing and Logistics of CEB

The production of CEBs is like that of fired earth blocks, with an exception of the firing stage. The diagram on figure 4 which represents the production process of CEB can be expanded into the following key procedures in the diagram below. Soil is extracted from the quarry and dried by spreading in thin layers or passing through a hot-air cyclone, then pulverized to break up lumps of clay and screened to eliminate unwanted elements after general preparation. After that the soil is measured out by weight or volume before dry mixing, which is done to maximize the

effectiveness of a stabilizer in powder form and wet mixing done to add water directly in the form of a liquid stabilizer.

The reaction time varies depending on the nature of the stabilizer before measuring out the amount of mixed material for optimal block density. The compression of the mixed material comes right after and then removing the block from the mold, thereafter, allowed to cure and dry out in order to acquire optimal quality of the product. The blocks produced are characterized into 4 main types namely: solid blocks; hollow blocks; perforated blocks; and interlocking blocks. In the production of CEBs the major factors that need to be taken into consideration are presented in the chart below.

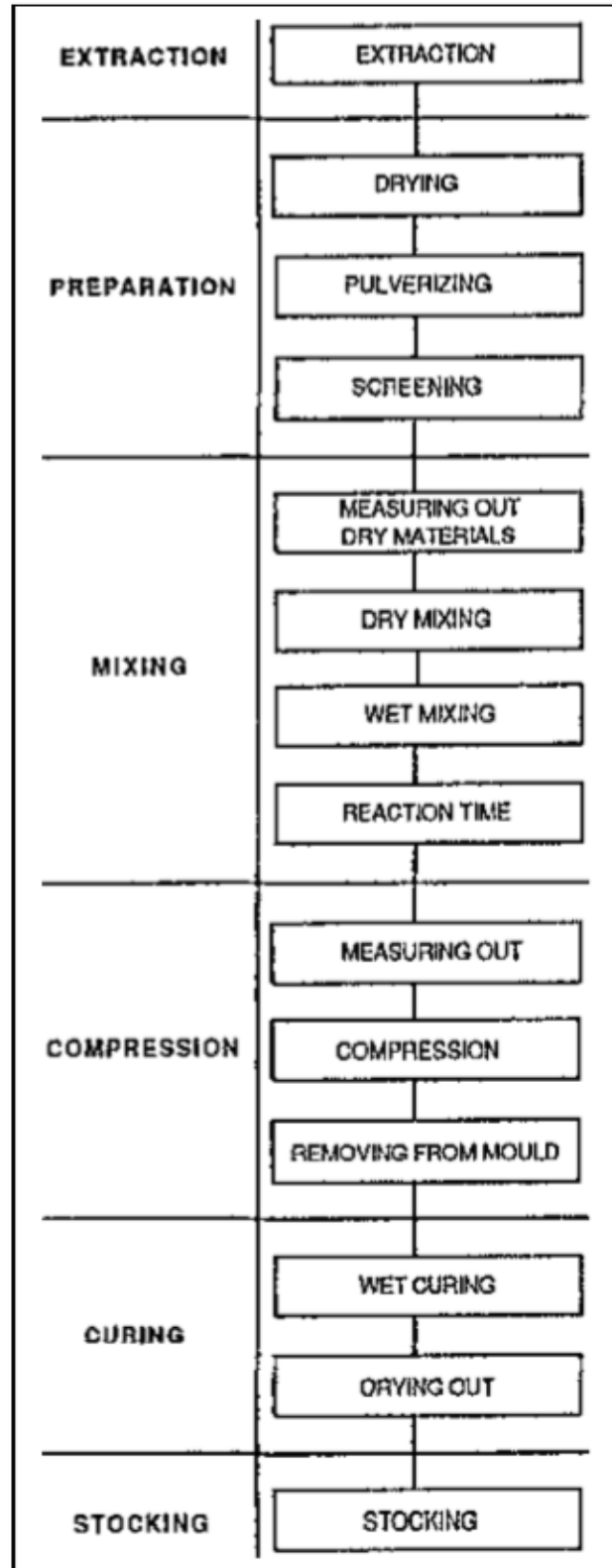


Figure 6- Production cycle of compressed earth blocks [CEB]. (Source- Rigassi, V. 1985)

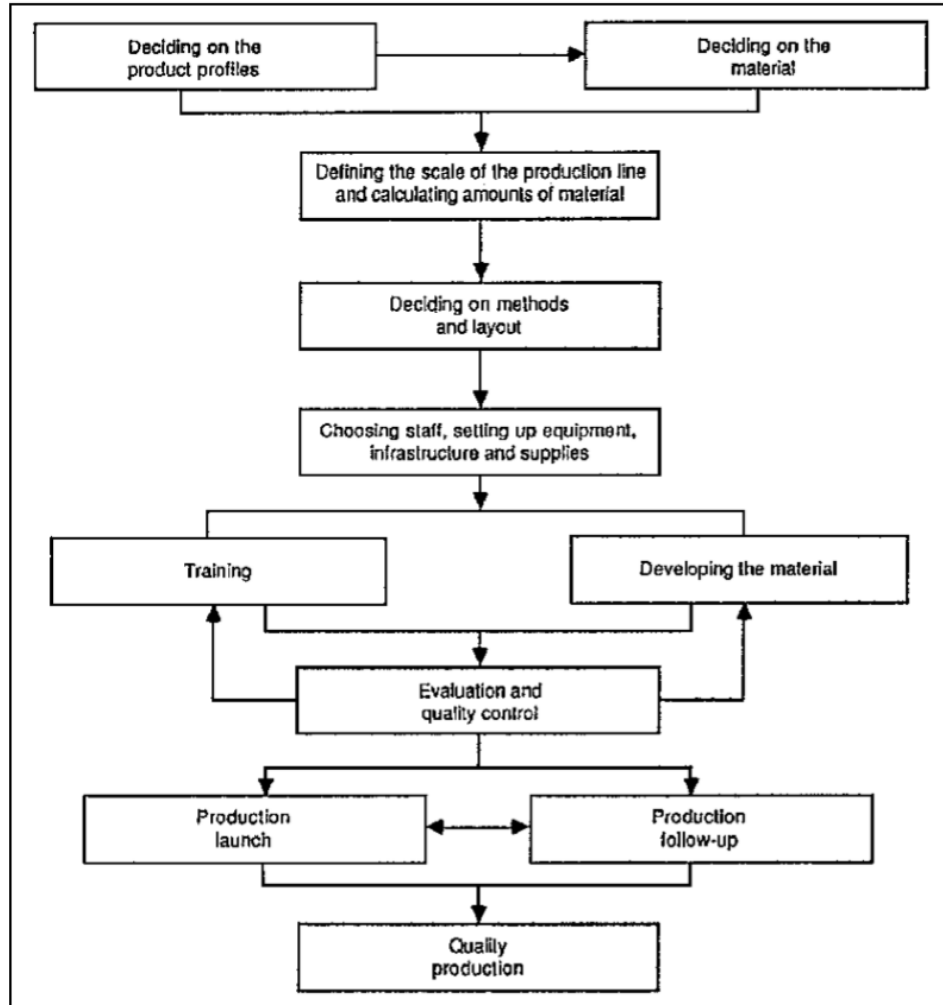


Figure 7- Compressed earth block [CEB] production (Source- Rigassi, V. 1985)

Rigassi (1985) makes a comparison between CEBs and other masonry materials, including fired bricks, adobes and concrete blocks. This is done based on the characteristics, technical performance, and uses in masonry. Merely observing these characteristics, we can assume that CEB possesses better appearance in terms of surface texture and visual aspect when compared to adobes and concrete blocks. Also, other characteristics that stand out include CEBs wet compressive strength, thermal insulation, and the durability of structures produced. Nevertheless, fired bricks seem to possess preferable characteristics in terms of visual appearance and durability,

but as discussed earlier they are not sustainable when taking the amount of energy required for its production into consideration.

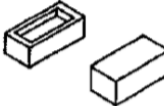
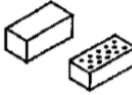

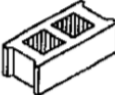
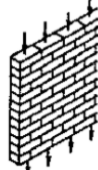
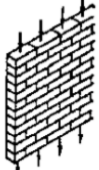
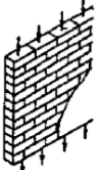
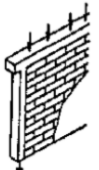
COMPARISON BETWEEN CEBs AND OTHER MASONRY MATERIALS					
Characteristics	Unit	CEB	Fired bricks	Adobes	Concrete blocks
SHAPE AND SIZE					
Type					
l x w x h	cm	29.5 x 14 x 9	22 x 10.5 x 6.5	40 x 20 x 10	40 x 20 x 15
APPEARANCE					
- Surface		smooth	rough to smooth	irregular	rough
- Visual aspect		medium to good	good to excellent	poor	average
PERFORMANCES					
- Wet compressive strength	Mpa	1 to 4	0.5 to 6	0 to 5	0.7 to 5
- Reversible thermal dilation	%	0.02 to 0.2	0 to 0.02	-	0.02 to 0.05
- Thermal insulation	W/m°C	0.81 to 1.04	0.7 to 1.3	0.4 to 0.8	1.0 to 1.7
- Density	kg/m ³	1 700 to 2 200	1 400 to 2 400	1 200 to 1 700	1 700 to 2 200
- Durability		low to very good	low to excellent	poor	low to very good
USE IN MASONRY					
		load-bearing  without render	load-bearing  without render	load-bearing  with render	infill  with render

Figure 8- Comparing CEB to other conventional building construction materials (Source- Rigassi, V. 1985)

In order to maximize efficiency in the production of CEBs it is important to consider some factors which include the layout of the manufacturing site; creating the proper soil mix with addition of stabilizers and water; block machine usage; and manpower usage (Reyes, 2011). The production lines on the CEB manufacturing site is installed based on how the equipment are assembled together. Rigassi (1985) highlights the differences using 3 main criteria: productivity, investment and the quality of labor-force employed, shown in the table below. In his research, Reyes (2011) found that when configuring the site layout, location of the soil stockpile, the block machine, the mixer, and pallet placement were quite important. However, Reyes also found that the rate of block output was relatively unchanged as long as everything was in close proximity to

allow for carriage of a bucket of soil from one station to the next. He argues that several mix designs have been tested over time but as of date the best was an addition of 6% Portland cement as stabilizers. In my opinion, this would still make the production affordable and sustainable but it is important that we test for the quality and cost of CEBs produced from the use of other chemical stabilizers like lime.

TYPES OF PRODUCTION LINE ACCORDING TO EQUIPMENT USED						
TYPES	TYPE 1 manual	TYPE 2 1/4 motorized	TYPE 3 1/2 motorized	TYPE 4 3/4 motorized	TYPE 5 motorized	TYPE 6 automated
Specific pieces of equipment	1 manual press	2 manual presses 1 mixer (250 l)	2 manual presses 1 mixer (250 l) 1 crusher/screen*	1 motorized press 1 mixer (250 l) 1 crusher/screen*	1 motorized press 1 mixer (250 l) 1 crusher/screen* mechanized transport **	1 automated unit automated transport
Production/day 29.5x14x9 blocks	600-1 000	1 200-1 500	1 200-1 500	1 500-2 000	1 500-2 500	5 000-6 000
Labour	9-10	11-13	10-12	9-11	8-10	8-10
Production area						
Total (in m ²)	380	630	630	805	2 300	4 900
Secure space	10	15	15	15	25	100
Covered space	30	100	100	55	50	300
Open air space	340	515	515	735	2 225	4 500
Investment in equipment (\$)	2 000	10 000	14 500	23 000	46 000	83 000
Infrastructure (excl. land) (\$)	2 250	4 150	4 150	4 500	10 000	38 000
TOTAL	4 250	14 150	18 650	27 500	56 000	121 000

Figure 9- Production line of CEBs according to equipment used

On visiting the CEB production site in Atiak, Uganda, I was able to acquire a brief understanding of the block production process and basic construction schematics. The process was quick and easily comprehensible, proving to me the potential of CEBs as a feasible complementary technology to the concept of self-help housing. From my experience on the site visit, the block machine was capable of running for hours so long as it was fueled but Reyes (2011) also found that any slight change in the soil mix must be accounted for by adjusting machine settings so as to maintain uniformity in the blocks produced. At this point, we need to make note of the fact that this requires expertise, and it is important to train people on how to operate and adjust the machine

to maintain quality control of the blocks. The crew required to maximize the production of CEBs ranges from 6-8 persons based on the production line setting, and organization. Nevertheless, a best practice manual for using CEBs in sustainable home construction argues that this team is capable of producing between 1,500 and 2,000 blocks per day using a single hydraulic block machine (Bowen, 2017). This number coincides with that of my research in Uganda, and that of Reyes (2011) who found that a 7-person crew produced 100+ blocks per hour. Accordingly, he makes a breakdown of the crew as follows:

Table 1- Crew requirement in the production of CEB

NUMBER OF PERSONS	FUNCTION
1	Monitoring machine & carrying out quality control on blocks
1	Receiving blocks & stacking them on pallets
2	Operating mixer & loading block machine
3	Sifting soil & stocking sifted soil at mixer
1	Operating tractor (if necessary)

On the other hand, the CEB best practice manual discussed above recommends 3 people on the CEB maker; 2 people performing the bulk mixing and loading of the batch mixer; and 1 person doing inventory and moving pallets to the curing location; with an optional seventh crew member responsible for quality control by testing blocks from random batches, including ordering supplies and filing in if production levels justify for added expenses. It is important to make note that the process of manufacturing CEBs might be simple but not easy, as the quality of the blocks produced is just as vital as, if not more than the quantity acquired most especially in the early

stages of training if we want to expand employment opportunities and make valuable the technology in affordable housing production.

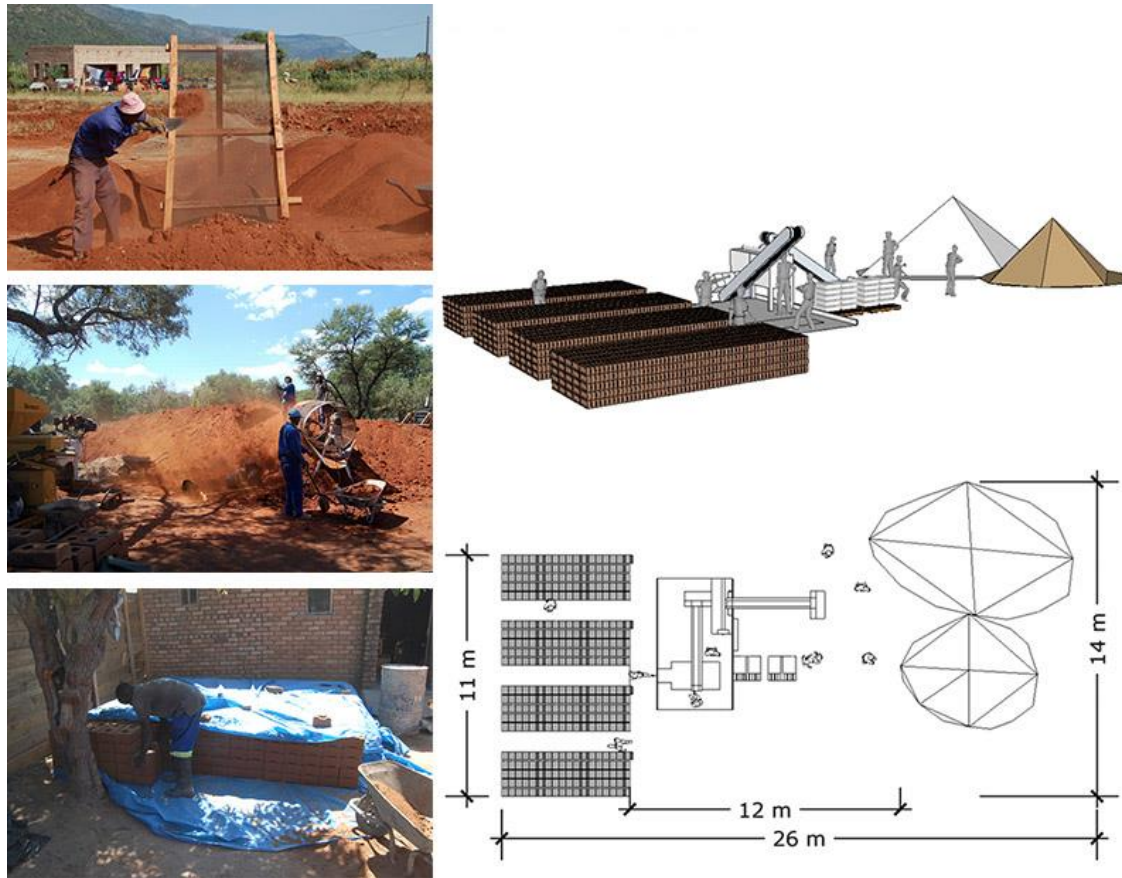


Figure 10- Block yard layout and CEB on-site production process (Source: Dwellearth)

2.4. Integrating Compressed Earth Block [CEB] Technology into the Concept of Self-Help Housing

The 2030s Sustainable Development Goals (SDGs) targets to ensure adequate, safe, and affordable housing, including basic services and upgrade of slums. If one of its goals aims to make cities and human settlements inclusive, safe, resilient and sustainable, in the evident presence of the billions of people with lack of basic services and millions living in slums of developing countries, I see no better alternative at this point in bridging this gap than incorporating the concept of self-help housing. The housing problems cannot be tied singularly to a unique problem of

inelasticity of supply but also to the scarce availability of resources, high cost of building materials, dead human capital, bureaucratic incompetence, large proportion of illegal settlers, heterogeneous physical stock, insecurity in tenure rights, inaccessible mortgage mechanisms for the poor, and high rents in urban settlements, even so, the lack of a comprehensive approach of housing policies to deliver on its objectives. Hence, after reviewing the series of literature it is in my argument to pose that the compressed earth block technology could serve a potential alternative construction technique in complementing the concept of self-help in the provision of affordable housing considering its cost and time efficiency, even so, the quality and homogeneity of structures produced.

According to John F.C. turner's argument for self-help housing in the provision of basic shelter and services, it allowed poor families to expand their units over time as their savings and resources permitted, as well as, using their own labor to maintain and increase their wealth over time. Housing can be perceived as a catalyst for urban development and wealth accumulation, most especially if placed at the center of the development as discovered in the cases of Chile, Turkey, Sri Lanka, and Singapore. In order to increase the standard of living of humans in developing countries, there is a need to address the level of wealth, comfort, goods and necessities available to the different socioeconomic cohorts in a geographic region, which for the purpose of this research would be the poverty population of sub-Saharan Africa. To reinforce the goal of poverty alleviation in sub-Saharan Africa and place housing at the center of economic development, there is a need to flip the script by addressing the scarcely available resources and allowing families to provide for their basic needs through expansion of their units with time, hitherto the feasibility of compressed earth blocks construction technique.

The United Nations Departments of Economic and Social Affairs asserts that in order to pursue a successful self-help housing project, the following seven (7) steps must be realized satisfactorily: i.) mass construction; ii.) training artisans for the building industry; iii.) working hours; iv.) size of groups; v.) team method; vi.) temporary and core housing; and in terms of design and use of materials: vii.) expandable houses. On the other hand, Bredenoord (2017) states that the applicability of building materials is determined by i.) the availability of materials; ii.) the culture of making building materials; iii.) the construction methods; iv.) the power of individuals, households and residents' groups; and v.) the willingness of entrepreneurs to participate in house construction. To integrate the CEB technique into the concept of self-help housing, there is a need to synthesize these set requirements in investigating best practices in self-help housing by employing Westendorff (n.d.) factors for adequate housing namely: affordability, livability, security, and sustainability. Although for the purpose of clarity I would be referencing some of Altmann (1982) set comprehensive approach to self-organization which includes legalization; flexible planning; lowest standards; internal resettlement; minimum formal organization structure; on-site authorities; low-level partners; financing conditions; and local technical service off.

In order to explore the feasibility of CEB technology as a potential complement to self-help housing, I would like to postulate based on the above factors highlighted by UNDES, Bredenoord, and Westendorff that the dominant factors required in order to successfully realize Turner's argument for self-help housing include a.) tenure security; b.) affordability; c.) capacity of individuals, households, and resident groups; and d.) sustainability in social organization.

First, the issue of tenure security as Bredenoord, & Lindert (2010) point out is considered by the school of self-help as the prime requirement for self-help housing projects. Pugh (2001) estimated that self-help housing constitutes 30-70% of the housing stock in developing countries,

and Altmann (1982) claims that about 30-60% of the overall population in developing countries are squatters, showing the existing method of construction thereby leading me to an assumption that there is a high potential for building and formulating different sizes of groups which is the basic unit of self-help housing. Hence, there is a need to increase security in land tenure rights to free squatters from the stigma of illegality. In investigating how tenure was administered in the cases of self-help housing, I would cross-examine how it was defined and measured. On the other hand, I ponder the role of implementing certificates of occupancy, land use rights certificates, and joint titles in enforcing tenure security. In general, the three areas to be examined include information, rights, and the market. According to the UN-Habitat for a better urban future, secure land and property rights are essential to reducing poverty because they underpin economic development and social inclusion.

Second, I believe that the issue of affordability could be reconciled since self-help requires mass construction, and the maximum potential of CEB requires a large-scale level of construction to save cost, and time, as well as the use of only about 1% of the energy required in manufacturing and producing the same volume of cement concrete. Also, there is an availability of the raw materials required to produce the earth blocks which include mainly earth, water, and only about 5% of ordinary Portland cement. The compressed earth block as mentioned earlier is an evolution of the adobe bricks, which is a well-known construction technique but unfortunately, the adobe requires a large amount of wood and energy for production, especially in mass construction. The products of both techniques represent an existing culture of building materials in sub-Saharan Africa which favors resiliency and robustness. In addition to the problem of secure tenure, the lack of affordable housing is one of the major causative factors for increasing squatter settlements. The poverty population is quite high in sub-Saharan Africa, while the housing sector focuses on

producing shelter for the middle-high income population. Therefore, to bridge this gap there is a need to create affordable housing for the low to very low-income strata population. I would be evaluating the relationship between the factors of affordability in self-help housing, which ranges from the cost of accessing land for construction to acquiring building materials and tools; hiring labor and technology; and acquiring skills in construction, required to establish the first basic shelter.

Furthermore, since there is an existing capacity or power of individuals, households, and resident groups to thrive in creating shelter based on their needs, the compressed earth block technology requires minimal standards and formal organization structure that could help realize a number of housing supply on the market within a short period of time, simultaneously training artisans for the building industry thereby creating employment opportunities in the labor market. More so, slum and squatter settlements revitalization has often been done via forced evictions thereby leading to the creation of other slum dwelling locations elsewhere. We could characterize the power of individuals, hence the need to retain the inhabitants within their neighborhoods by gradually demolishing and reconstructing houses one after another, through the establishment of temporary and core housing through internal resettlement. This would, in turn, allow for families or groups to expand their units over time as their savings and resources would permit, using their own labor and sweat equity to maintain, and increase their wealth. To assess the role of the capacity of groups in realizing the potentials of self-help housing, I would examine the degree and scale of mass construction employed, as well as, how the capabilities of each participant were managed to compensate for human failure.

Finally, I believe sustainability which encompasses the built and natural environments, economic prosperity, and social stability and equity amongst other self-realizable possibilities can

be tied to the effectiveness of the social organization. In order to address sustainability in a social organization, it is important to investigate from the cases how the working hours, team method, and size of groups were administered to realize an effective scheme including sustaining adequate sources of income. Also, there is a need to examine how the willingness of entrepreneurs to participate in housing construction was tackled.

Eventually, integrating the factors aims at livability which refers to the sum of all factors affix to the quality of life, and ascertaining the overall goal of integrating CEB into self-help housing which is to create adequate, safe, and affordable housing and basic services to upgrade slums and alleviate poverty in sub-Saharan Africa.

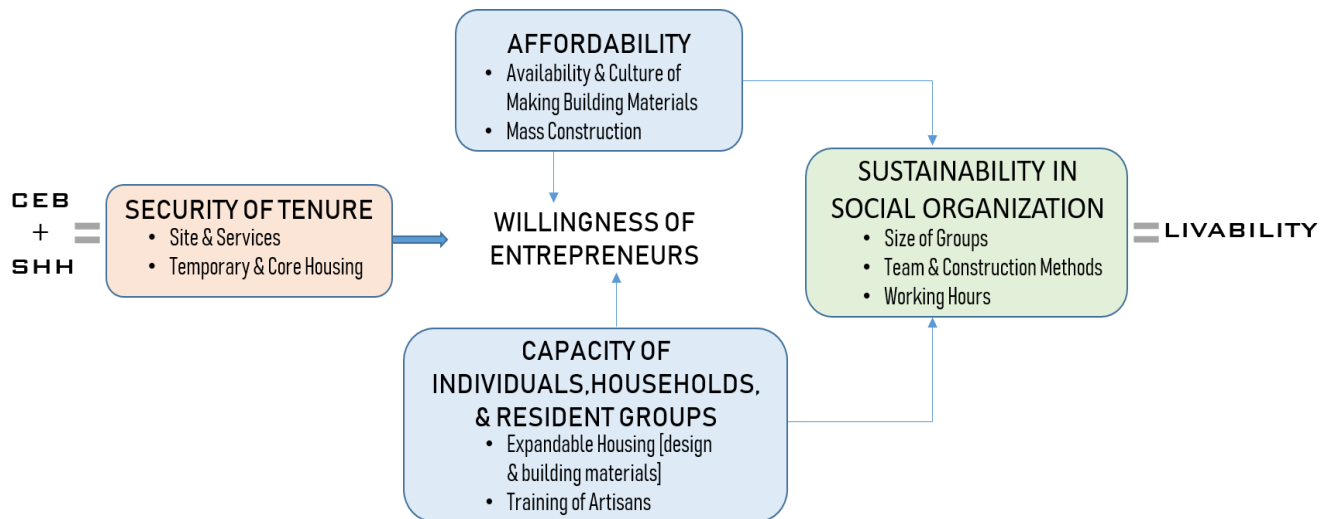


Figure 11- Proposed factors for integrating compressed earth block [CEB] technology & self-help housing (Source: Author)

2.5. Methodology

My research focuses on the use of a quantitative method of approach, investigating the research questions with the use of available literature, and best practices from the past. I examine three case studies in developing a model for the integration of CEB technology into self-help

housing. The four factors listed above are questions that I explore from the case studies in Botswana, Indonesia, South-Africa, and Zambia. The selection of these cities was quite random but they all recorded a high rate of rural-urban migration during the post-colonization period in Africa.

In the cases, I examine the background of the selected cities and the causes of migration, including other underlying contexts of urbanization within the area. Thereafter, the four factors of affordability; security of tenure; capacity of individuals, households, and resident groups; and sustainability in social organization are investigated in the cases.

At the end of my research, I will have investigated the possibility of implementing compressed earth block technology as a sustainable alternative to the provision of affordable housing in sub-Saharan Africa, when complemented with the concept of self-help housing. On the other hand, I presume there might be limitations in accessing some information but nevertheless, the document would serve as a base for further research on the quest for affordable housing in sub-Saharan Africa.

3.0. CASE STUDIES

Self-help housing as the literature presents is a concept that has been practiced since the 1970s and seen as a potential solution to addressing the issues associated with the lack of affordable housing in developing third world countries. This paper looks to address one of the key problems of the century, which is housing as the United Nation’s sustainable development goals of 2030 asserts. For the purpose of this research, this chapter investigates cases of self-help housing practiced in three (3) of the rapidly growing cities of sub-Saharan Africa that resulted from an increasing magnitude of urbanization. The cities examined include Lusaka, Zambia; Nairobi, Kenya; and Gaborone, Botswana.



Figure 12- Location map of case studies from sub-Saharan Africa

3.1. Case #1- Lusaka, ZAMBIA

3.1.1. Background and Context

In the 1980s Zambia was one of the most urbanized nations in sub-Saharan Africa with over 40% of its population living in urban areas. Prior to that were the years pre- and post-independence between 1963-1969, which recorded growth rates of 7-10% per annum (C. Bryant, 1980). This was largely as a result of rural-urban migration, in the quest for higher urban incomes, greater employment opportunities, presence of relatives in the urban areas, and distance to the city, as was the case in many African countries but Zambia had an additional factor which was an urge for the economic benefits of town life following the post-colonial era. Lusaka, Zambia's capital city was one of the largest collectors of the immigrant population. Within the decade post-independence, the city recorded over a 200% increase in population, hence, leading to high demand for low-cost housing and a resulting 40% of the population living in unauthorized areas (C. Rakodi, 1989). Considering the failure of policies to keep up with the rising demand for housing, a new policy of upgrading selected squatter settlements was introduced in the Second National Development Plan, more so, providing new housing in site-and-service areas (C. Rakodi, 1989). Unfortunately, the economic situation in the 1970s made it difficult, in the presence of scarce available resources required to implement the housing program.

3.1.2. The Lusaka Self-Help Housing Project

The Lusaka project stemmed from Kafue as shown in the map in fig.12 below, a small township about 30km south of Lusaka which collaborated with local citizens and the American Friends Service Committee in the early 1960s, including expatriates in devising a process of mutual self-help housing. On migrating to Lusaka, the experience from the project, and more significantly the collective skills acquired became instrumental in the larger housing project. The

Lusaka self-help project emanated from a partnership between the World Bank, the Ministry of Housing, the United National Independence Party (UNIP), the American Friends Service Committee, and community organizers among the Lusaka squatters. On the one hand, both projects might look similar but the increase in size and organizational constraints caused for much focus on individual efforts.

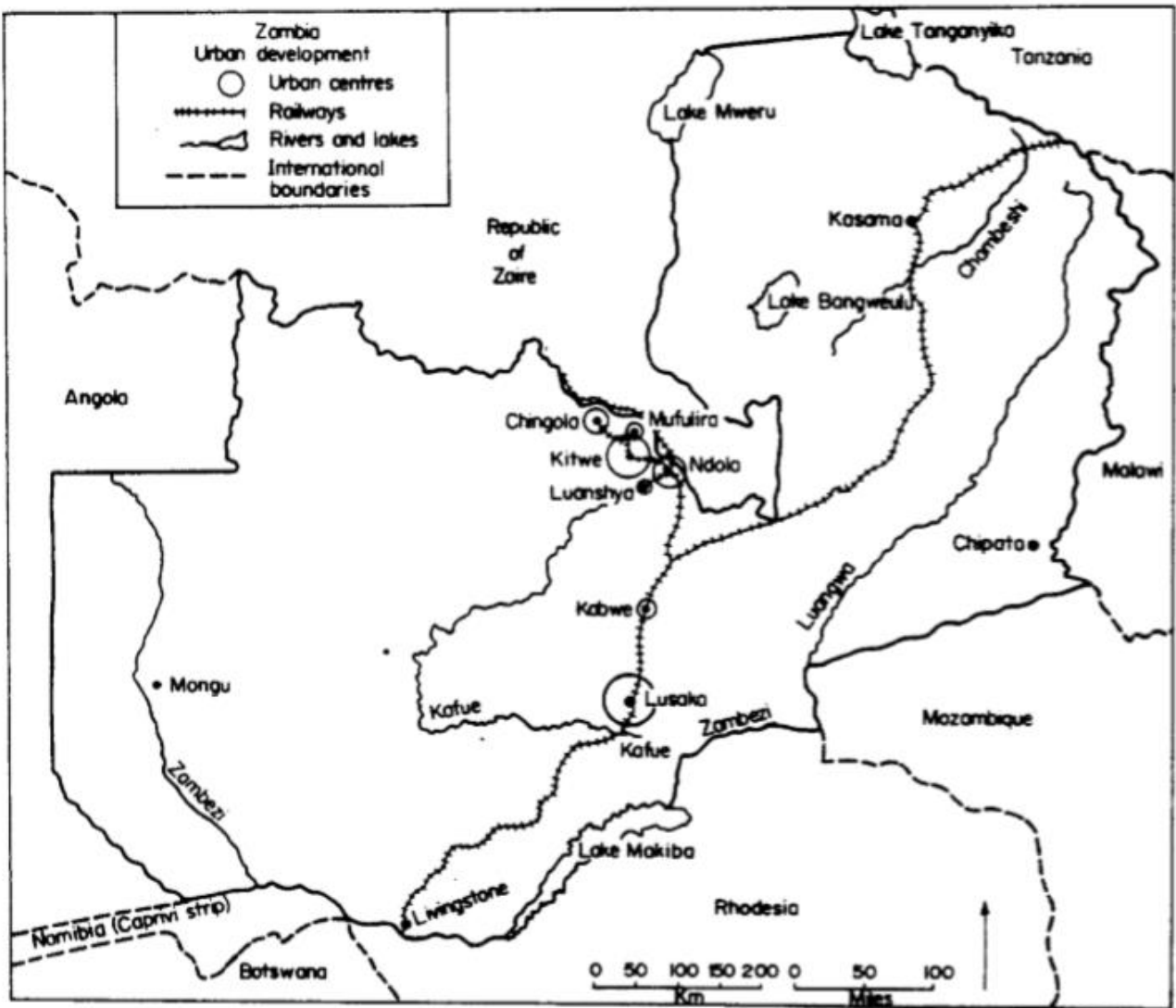


Figure 13- Project location (Source: Barbara Sutton, 1978)

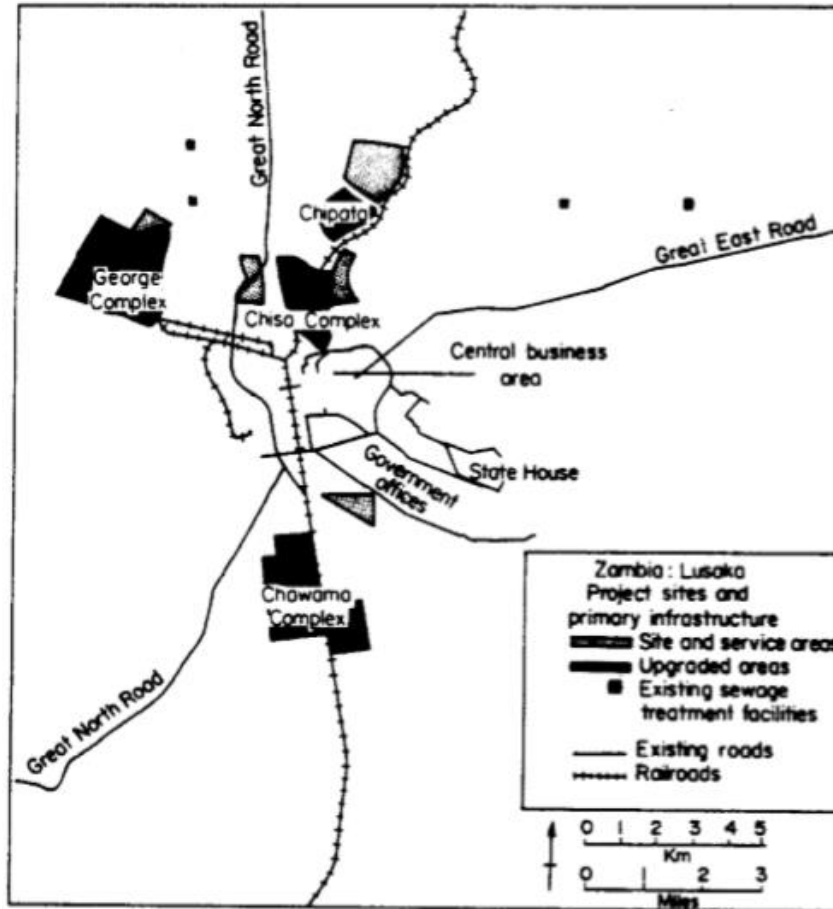


Figure 14- Lusaka project sites (Source: Barbara Sutton, 1978)

3.1.3. Evaluation of Factors

3.1.3.1. Security of Tenure

At Zambia's independence, the policy declared was 'housing for all' and freedom of movement, which Mulwanda and Mutale (1994) argue spurred the rural-urban migration most especially for adult women. The urban immigrants assumed that vacant land had no owner and value, thereby claiming and investing in them. On the other hand, those who recognized the legal system of land allocation considered it to be a bureaucratic maze incapable of fulfilling their needs (M. Mulwanda, & E. Mutale, 1994). After years of debate and as the growing landless urban community grew, these areas were a social and financial asset, and with the aid of the World Bank, it was decided in 1973 that there was a need to improve their conditions and regularize tenures.

The Housing (Statutory and Improvement Areas) Act of 1974 was an acknowledgment of the rights of people living in unplanned areas, giving rise to the government's acceptance of illegal settlements and its commitment to the provision of minimum infrastructure. The aim of the Zambian Ministry of Housing was figuring a way to respond to the actual needs and growing population of urban squatters. During the Lusaka project implementation between 1974 and 1981, a Housing Project Unit (HPU) was established within the City Council to administer the project with its own engineering, financial and community development staff, and following that, the areas have been incorporated into the legal administration of the Lusaka Urban District Council.

The 1974 act provided the introduction of 99-year title certificates to plots in site and service areas; and 30years occupancy right licenses to owners of houses in upgraded areas, including the installation of physical and social infrastructures. In the 1975 Land Reforms, through a socialist approach to wealth distribution largely built on tradition and the ruling party's philosophy on Humanism, all freeholds were converted to leaseholds; vacant and undeveloped lands were nationalized; a declaration made that undeveloped land had no value; and all land transactions were subject to the state's approval at a price that reflected the land improvements.

3.1.3.2. Affordability

In the presence of the increasing squatter population, and declining economic situation it was important that any form of housing production be affordable to the marginal poor on a large-scale with effective strategies, which was the objective of the World Bank's involvement. It was perceived that the use of self-help in housing construction and infrastructure installation would reduce the costs of provision. Although residents resettled in overspill areas were entitled to a loan, which in theory would enable them to buy the materials to build a two-room core house that could be extended in the future but unfortunately, in practice, inflation level in the cost of building

materials exceeded the increase in loan amounts available. The effect of this was that residents profusely adopted higher standards of construction beyond anticipated, as well as, hiring labor to build their houses. This, in turn, led to resident's decisions to opt out of the scheme or for those that resettled, at an opportunity cost sacrifice other expenditures and default on loan repayments. The administrative capacity was also a setback to this process because of the inability to effectively monitor and enforce a comprehensive scheme that ought to be sustainable over a set period of time, most especially on such a large-scale project.

3.1.3.3. Capacity of Individuals, Households, and Resident Groups

The Lusaka project planners were willing to involve community residents of the unauthorized areas in the decision-making process to strengthen self-reliance and encourage a continuance on further improvements. In implementing the project, it was thought that involving residents in infrastructure provision would increase satisfaction and generate a sense of responsibility in its maintenance. Initially, the plan was that residents would participate on a community basis, by self-help installations of utilities and infrastructure, on a group basis, by incorporating individual water supply as against shared; and on an individual basis, by engaging them in constructing their own houses. The level of participation given residents ranged from information collection to the opportunity to state their preferences and priorities, as well as, contributing to planning and design decisions in the housing process. The problem was that although the National Housing Authority was largely involved in the project planning in advance of loan approval and accounting of residents' views, there were no opportunities for them to participate directly in the World Bank's funded project. As Rakodi (1989) would argue, it was because the project had to be prepared quickly and in detail, leaving little time for time-consuming processes of consultation and participation. Also, the level of capacity of individuals incorporated

was largely limited to unskilled labor, such as drilling trenches for drains or water supply in exchange for building or supply materials to the value of labor contribution. The discrepancy here is that the aim of self-help housing is to incorporate the labor and sweat equity, including creativity of residents but in this case was largely limited to the decision-making process and unskilled labor.

3.1.3.4. Sustainability in Social Organization

The main feature of the Lusaka project was its emphasis on participation by the squatters in decision-making, even much more beyond its scale or self-help approach, as it was already a characteristic of these areas. The households in the designated areas were organized into small groups by the community development workers, who engaged them in discussions on the problems they were encountering. The households in the upgraded areas and adjacent resettlement areas were arranged in groups of 25 around a shared infrastructure installation, for instance, water taps. Also, two groups were organized into a UNIP section which formed the basis for further improvements. These small groups then chose representatives to become members of the dominant local political party- UNIP, expressing their views at the next high level and encouraging greater inputs, as well as, allowing for a collective interest. Discussions and financial savings are discussed and allocated respectively over weekend sessions, among other pressing issues. It could be argued that this brought about a sense of mutual ownership of the project, but the question is if this was enough to sustain its prosperity over time.

3.1.4. Synopsis of the Study

Lusaka, ZAMBIA	
SECURITY	<ul style="list-style-type: none"> 99-year certificates 30years occupancy right licenses 1975 Land Reform: <ul style="list-style-type: none"> Freeholds converted to leaseholds Vacant and undeveloped lands were nationalized Undeveloped land had no value Land transactions subject to state approval
AFFORDABILITY	<ul style="list-style-type: none"> Material loan for 2-room core house Inflation level took effect on loans: <ul style="list-style-type: none"> Residents adopted higher construction standards Residents opted out of the scheme Default in loan repayment
CAPACITY OF INDIVIDUALS, HOUSEHOLDS & RESIDENT GROUPS	<ul style="list-style-type: none"> Residents involved in decision-making process Implementing the project: <ul style="list-style-type: none"> Community basis- self-help installation of utilities & infrastructure Group basis- Individual water supply as against shared Individual basis- Engaging residents in constructing their houses Limited largely to unskilled labor
SUSTAINABILITY IN SOCIAL ORGANIZATION	<ul style="list-style-type: none"> Largely maintained by involving residents in decision-making Group Organization: <ul style="list-style-type: none"> Small groups- Number of 25 2 groups each organized into a UNIP section Incorporating meetings & discussions over weekend

Table 2- Evaluation of factors in Lusaka, Zambia (Source: Author)

3.2. Case #2- Nairobi, KENYA

3.2.1. Background and Context

In the 1970s, Kenya’s largest City, Nairobi experienced a high demand for affordable and low-income housing as a result of rapid urbanization from rural-urban migration. Most of the immigrants were of the younger cohort population who came to the City in search for better jobs to improve their levels of income and form of living, as well as, improving the lives of their

families. The notion of these immigrants was that the Country's capital city was a place of abundance but unfortunately, the urban economy proved to be quite the opposite especially with their lack of formal education and special skills preventing them from acquiring formal jobs leaving them with no resources other than their own labor and self-help. The three main housing types encountered by the immigrants include "the private" which was the formal housing system for middle and upper income groups, comprising of about 33% of the immigrants, "the public" which was primarily managed by the local authorities and comprised of about 30%, and "the popular" which was the most suitable option available to the immigrants, housing about 37% of the population (Soni, 1981). This gave rise to the introduction of the Dandora Community Development Project (DCDP), which was the first large-scale urban housing project incorporating a partnership between the Government of Kenya and the World Bank.

3.2.2. The Dandora Self-Help Community Development Project

The concept of self-help housing in the case of Kenya was adopted via the use of a site and service approach in aiding urban residential development for low-income residents of major urban centers like Nairobi. The idea was to address the increasing need for low-income housing and alleviate associated issues of squatting by allowing the construction of urban dwellings for residents with the use of their own available self-help resources, alongside subsidized aid to save costs, increase community participation, as well as, acquiring valuable educational experience through the building process among other social and economic benefits.

The implementation of the project was administered by the Nairobi City Council (NCC) between 1973 and 1975, with the completion of its first phase in 1976 which consisted of 1029 plots. The Dandora Community Development Department (DCDD) possessed management,

finance, technical, community development, and legal sections that were responsible for coordinating tasks and overseeing the actual implementation of the project.

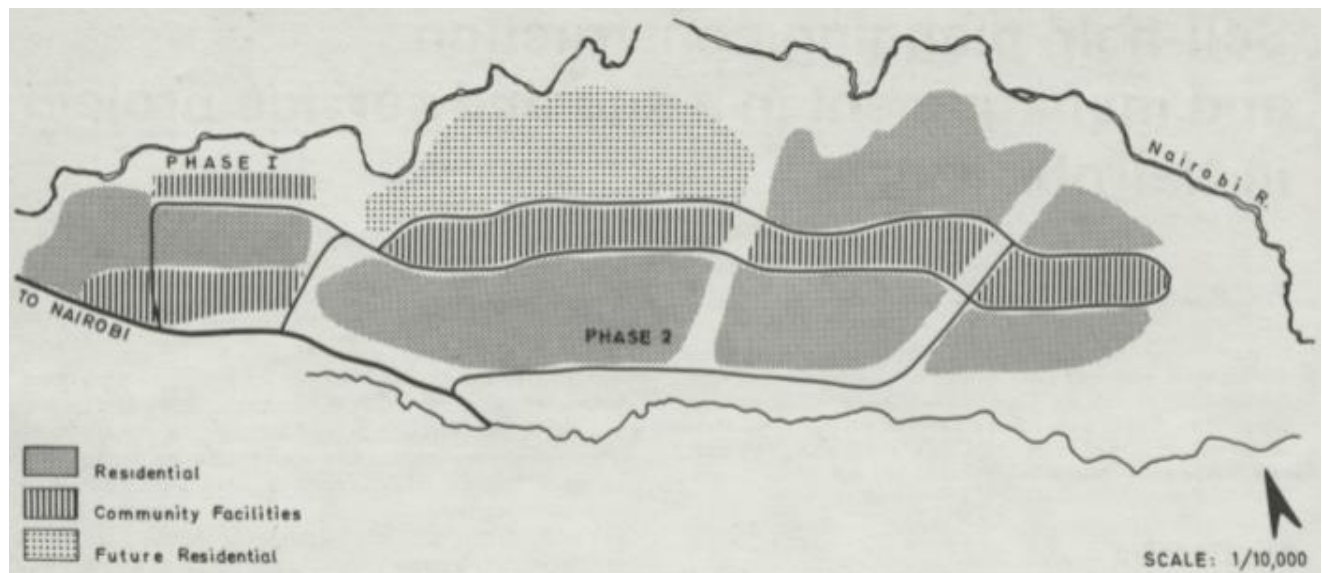


Figure 15- Sketch Plan of the Dandora Community Development Project (Source: Praful Soni, 1981)

3.2.3. Evaluation of Factors

3.2.3.1. Security of Tenure

The DCDP was initialized with a preconceived notion of a site and service approach which could mean holding tenure security at a high standard in the project. It placed a strong emphasis on the builder-lessee security in shaping the construction, planning, and management of the processes necessary for self-help housing. Also, the allocated beneficiaries to the plots were awarded a leasehold tenure of 50 years and deed title was issued after the resident constructed a dwelling approved by the Dandora Project Department. Beneficiaries had to comply with lease agreements which include i) undertaking construction of dwelling according to minimum standards set by the DCDD, within 18 months; ii) pay all charges promptly; iii) sublet rooms only on conditions specified by the project administration; and iv) notify the administration of any intentions to exit the project and conform to regulations for transfer.

On the other hand, each plot was provided with basic services consisting of water connection to water closets, shower and gulley basin, including sewerage and wastewater drain in a contractor-built “wet core.” The wet core and shelter unit options available were designed to accommodate different income levels within the low-income sector. More so, community facilities available to accommodate the beneficiaries included primary schools, health centers, community centers, daycare facilities, sports facilities, and markets, among other infrastructures.

3.2.3.2. Affordability

In addition to the basic services and infrastructures available to beneficiaries in order to allow for easy transition, the project scheme aimed to address an estimated household earning income range for about 40% of Nairobi’s households in the mid-70s. The project expected about 6,000-10,000 residents on completion of its first phase in November of 1976. Also, the physical components of the project were based upon policies advised by the Nairobi Urban Study Group (NUSG) which was responsible for the Nairobi Metropolitan Planning Strategy until the year 2000, allowing for housing projects to be located within accessible, existing and planned employment centers. Furthermore, the shelter units provided three options that offered participants construction material loans for development through self-help, and the “wet core”, including some of the options providing contractor-built rooms and kitchens as seen in the figure below. The repayments on loans were allowed 20-30years, with the first installments on material loans commencing after 18months which might seem to be enough time although, the coinciding of the material loans with that of the plot loan repayment schedule might have caused some residents to default or break some of the rules set by the DCDD.

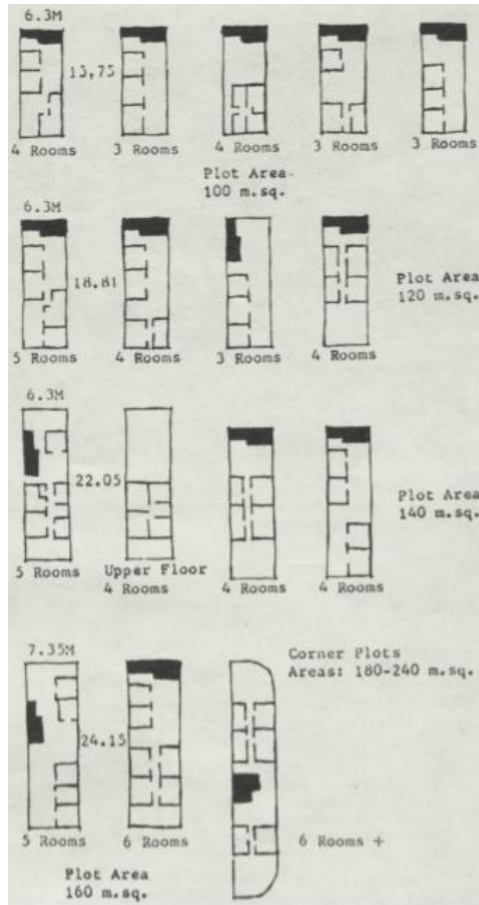


Figure 16- Typical house plans prepared by the Technical Section of the DCDP, with "wet core" completed. (Source: Monitoring and evaluation study of DCDP)



Figure 17- Average completed dwelling, with a planned extension and constructed ground-floor slabs. (Source: Praful Soni, 1981)

3.2.3.3. Capacity of Individuals, Households, and Resident Groups

In addressing the capacity of the residents who were largely low-income immigrants with the only available resources to them being their own labor and self-help initiative, some underlying assumptions of the DCPP included allowing for an autonomous process in the management of the house planning and construction, including mobilizing their own resources in responding to the economic environment in ways that best suit their needs. This allowed arousing the willingness of immigrants and participants in the project even though they rarely got the exact picture about the plots and dwellings, including what the project entails with respect to self-help. Although this on the other hand, affected the flow of the projects success as the participants often expected to get completed dwellings and have no role in their construction, as well as, not able to distinguish between the “wet core” units as the only provision on the plot that ought to allow for employing self-help methods in completing the remaining plot.

The participants were strongly interested in the project because of its sense of security through tenure and affordability but the initial deposits required within a short time quickly raised problems, allowing them to risk the reallocation of their plots and for some of those that went onwards it was soon a problem to conform with set rules by the DCDD in construction.

3.2.3.4. Sustainability in Social Organization

There were three principal forms of self-help construction explored in the Dandora Community Development Project, which included the allottee-built form of self-help; the subcontract form of self-help; and the building groups form of self-help.

The first, allottee-built form embodied the use of allottee in planning, constructing, and managing the building process, according to the allottee’s available time. The allottee is central in decision-making but could seek help in the form of skilled or unskilled labor, which is often free

and returned in the favor of reciprocity. Some of the constraints of this form include the lack of initial finance, commitment towards jobs and sometimes family sheer size, transportation costs of materials, and the inability to conform to set standards by the NCC and DCDD, for both unprecedented or selfish interests.

The subcontract form of self-help on the other hand is quite popular and limits the allottee's role to marginal, allowing for contracting out activities that cannot be self-handled by the allottee. The participants in this form include the allottee and the "fundi", often known as artisans or semi-skilled contractors. Technical decisions as regards materials are made by the fundi, while the organization of the construction team including delegating responsibilities and tasks are directed to the "vibarua" who are the other laborers. The allottee is left with the job of endorsing the fundi's decisions, supervising the construction team, and making available the necessary finances.

The building groups as a form of self-help are built on the basic principle of "mutual financial assistance". The groups are initiated by the residents of the project and the DCDD through the Community Development Department of the project, with its basic objective aimed at assisting individual group members of about 15 people in building a room through the collective use of human or material resources. It is built on the foundation of the "helpless" and those who lack ideas about construction. The idea is that once a room is built through mutual assistance and income is generated from subletting, it is used to construct another room while the allottee remains in a temporary shelter on the plot as seen in the figure below and continues to make contributions until the other members of the group complete their rooms. Each group collectively set their working patterns, schedule, methods and rules, including appointing an officer to keep accounts, set meetings and delegate responsibilities to the group. Also, often used is a raffle system in deciding whose room in the group should be built first, and in that order.

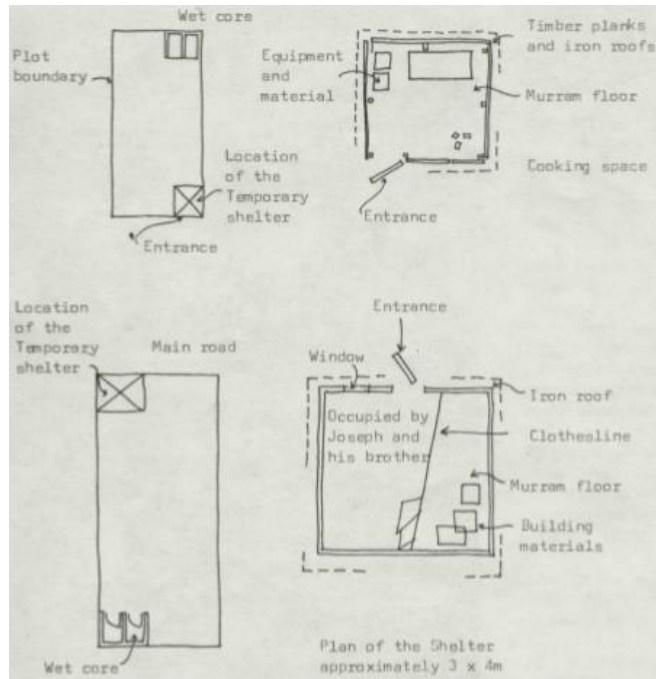


Figure 18- Typical layouts of temporary shelters (Source: Praful Soni field notes, 1981)

3.2.4. Synopsis of the Study

Nairobi, KENYA	
SECURITY	Site and service approach- "Wet core" Builder-lesse security 50-year lease-hold tenure Lease agreements: Undertaking construction within 18months Pay all charges promptly Sublet rooms only on set conditions by administration Notify administration of intentions to exit and conform to regulation transfer
AFFORDABILITY	Addressed income range for 40% of Nairobi's households 1st phase target- approximately 10,000 residents Focus on accesibility and existing planned employment centres Loan repayments were allowed a span of 20-30years 1st installments on material loans commenced after 18months
CAPACITY OF INDIVIDUALS, HOUSEHOLDS & RESIDENT GROUPS	Autonomous process in managing housing plan and construction Wet core allowed residents easy transition Level of literacy was a set-back
SUSTAINABILITY IN SOCIAL ORGANIZATION	3 forms of self-help construction: Allottee-built - based on reciprocity of rendered service Subcontract form- based on contracting to fundi & vibarua Building groups- based on individual groups of 15 people by means of mutual assiatance

Table 3- Evaluation of factors in Nairobi, Kenya (Source: Author)

3.3. Case #3- Gaborone, BOTSWANA

3.3.1. Background and Context

Following the independence of Botswana in 1966, just like many other developing countries, it faced economic, demographic, and social changes that led to increasing urbanization, even so, an increasing rate of rural-urban migration. The effect of this was a simultaneous increase in housing demand, as well as, other social, economic, and environmental problems most especially in its capital city, Gaborone. These problems took effect mostly in the low-income areas, causing deteriorating housing problem and an increasing number of squatter settlements. In order to address these issues and create an effective means of affordable housing supply for low-income households, the Country introduced the idea of self-help housing through the assistance of the International Bank for Reconstruction and Development (World Bank), and the United States Agency for International Development (USAID). The focus of the housing programs was in the city of Gaborone, which was home to government administration offices, major industries, as well as, over 10% of Botswana's population (J. Kampamba, et. Al, 2018).

3.3.2. The Self-Help Housing Agency [SHHA] Program

Among the national principles on which Botswana is upheld, the concept of self-reliance created the foundation for the SHHA program. The program was first introduced in 1973 and administered under the Gaborone city council, which incorporated the use of site and service approach that involved servicing of land, and its allocation to low-income beneficiaries to allow them to develop and expand their plots over time using subsidized government building materials loan. The people of Botswana in the past already possessed a culture of building adequate housing through self-help in rural areas, consequently, it was a cost-effective method of housing provision for urban dwellers (H. Ikgopoleng, & B. Cavric, 2007). The Accelerated Land Servicing Program

(ALSP) was introduced, alongside the Allocation of State-Land Policy in 1990; to implement an accelerated provision of enough serviced residential, commercial and industrial land in urban areas; and speed up the process of state-land allocation, including equitable land distribution, respectively.

3.3.3. Evaluation of Factors

3.3.3.1. *Security of Tenure*

Prior to the introduction of the ALSP, one of the foremost identified causatives for the shortages in urban housing was the deficit in serviced land, which was made evident in the introduction of the 1990 state-land policy. In order to address the housing shortages, it was, therefore, necessary to first see to the security of tenure through the provision of land. There were two forms of tenure employed, which included the Certificate of Rights (COR) and Fixed Period State Grant (FPSG). The former was viewed as an easy means of providing tenure that did not involve legal fees or surveys, while the latter was an improved deed used to fill the gap of serving as collateral for financial institutions with an additional cost for title registration alongside offering its holders a 99-year agreement. The tenure systems were leasehold and administered by the Departments of Land, under the Ministry of Land and Housing. The FPSG formed the foundation that allowed for SHHA residents to transfer their plots to other people via a private transaction, which did not require the City Council's approval as was the case for COR. On the other hand, plots were allocated at a seemingly slow pace for an average of over 5 years which allowed interested beneficiaries to lose patience, and for those that went on with the program, engage in the transfer of their plots (H. Ikgopoleng, & B. Cavric, 2007). More so, the survey done by Ikgopoleng and Cavric presents that just over 38% of the cohort that earned 500 Pula had titles for their plots, while 30% of those who earned more than 1000 Pula secured titles for their plots.

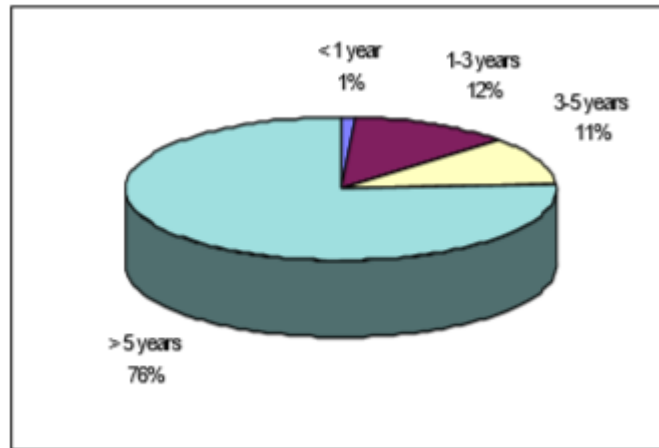


Figure 19- Applicants Waiting period for plots (Source: Ikgopoleng & Cavric field-survey, 2005)

3.3.3.2. Affordability

Although the aim of the SHHA program was to address the housing needs of low-income residents of Botswana, the project did not seem to be quite affordable after all based on the survey responses from the beneficiaries (J. Kampamba, et. Al, 2018). The change in the tenure system incorporated, from COR to FPSG required beneficiaries to pay costs for title registration was not helpful to the target group. Also, housing units were restricted to citizens of a particular area and income bracket which placed limits on the real target population, most especially women. In addition, the expenditure was reduced from its administration by the Central Government to the Urban Council, thereby causing a shortage of finances available to the program. The result of a decreased subsidy available to residents caused plot holders to secure finances from their own resources, hence, a default in repayment of building material loans. This is evident in the percentage of initial low-income beneficiaries who transferred their plots to others, even though the SHHA agreement states that plots cannot be transferred or sold within the first ten years, otherwise a vast penalty almost impossible for the low-income to afford given the average monthly income of beneficiaries.

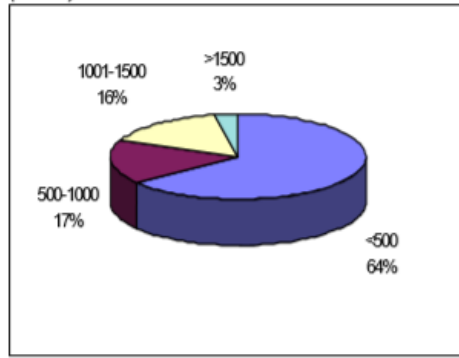


Figure 20- Survey Respondent's Monthly Income (Source: Ikgopoleng & Cavric field-survey, 2005)

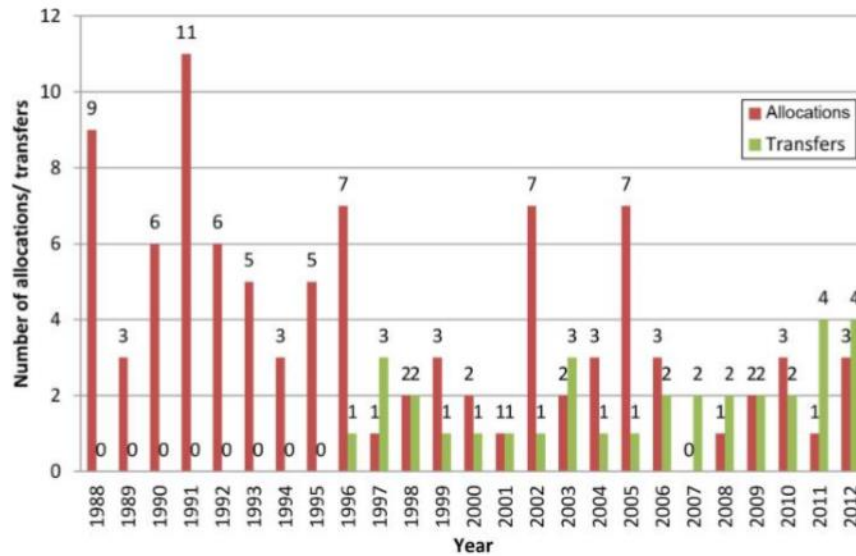


Figure 21- Number of Allocations and transfers recorded per year in old SHHA areas (Source: Field survey by Kampamba et. Al)

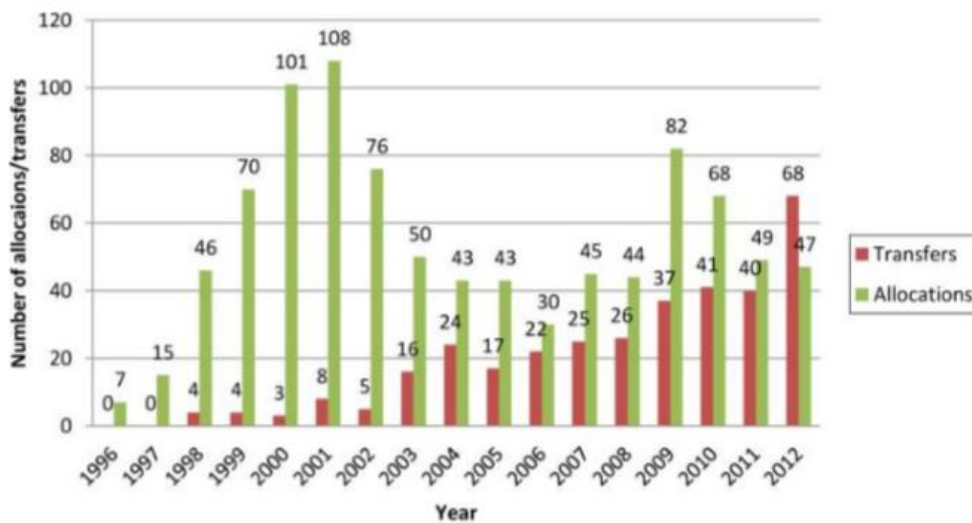


Figure 22- Number of Allocations and transfers recorded per year in new SHHA areas (Source: Field survey by Kampamba et. Al)

3.3.3.3. Capacity of Individuals, Households, and Resident Groups

The SHHA program was built on Botswana's principle of self-reliance with the aim of addressing the needs of its marginal population but results show that it is yet to realize these objectives. The fact that in the presence of a reduced budget available by the Central Government in financing the program, households still found a way to finance the development of their house from their own resources shows that there is still a strong power of residents in the capacity of self-help. The argument for self-help aims at building the capacity of individuals through sweat equity but the long waiting time for allocation decreased the commitment levels of interested parties, even so, the 2years given residents to fulfill development agreements in the presence of inadequate loans to cover construction cost further disrupted the project flow. The result of these was a transfer of undeveloped plots to those who could afford, often middle and upper-income class, hence, taking us back to the initial problem of illegal settlements and the demand for an increasing number of affordable units around major surrounding villages.

3.3.3.4. Sustainability in Social Organization

In the SHHA program, we could almost say there was little or no comprehensive approach in employing any forms of community organization, even though the majority of migrants to the urban areas were people who were used to community engagement in their rural areas. A majority of the migrants were of unskilled and semi-skilled low-income labor searching for jobs in the construction industry but the SHHA program was not able to capitalize on this in order to maximize their equity in form of sweat and self-help resources. This leaves us then with the question of what role the notion of self-reliance played in the Self-Help Housing Agency (SHHA). program.

3.3.4. Synopsis of the Study

Gaborone, BOTSWANA	
SECURITY	Certificate of Rights (COR) Fixed period State Grant (FPSG)- Legal fees & 99-year agreement Lease-hold tenure Slow pace of land allocation
AFFORDABILITY	Change in tenure system from COR-FPSG was unaffordable to low-income Housing system restricted to income bracket that placed limits on target popn.
CAPACITY OF INDIVIDUALS, HOUSEHOLDS & RESIDENT GROUPS	Built on principle of self-reliance Long waiting-time for allocation Large rate of transfer of undeveloped plots from initial beneficiaries
SUSTAINABILITY IN SOCIAL ORGANIZATION	No discussed available form of social organization

Table 4- Evaluation of factors in Gaborone, Botswana (Source: Author)

4.0. FINDINGS AND RECOMMENDATIONS

This chapter provides a summary of recommendations based on results and findings from the analysis of the literature in this research and case studies examined in chapter 3. The purpose is to make reflections based on the findings and highlight implications of such findings on implementing compressed earth block (CEB) technology as a complement to self-help housing in providing a solution to the crisis of affordable housing in sub-Saharan Africa. Also, it underlines some of the limitations encountered in the research, and how further research or practices in this line might be done to cater to these constraints. The discussion follows the factors assessed in the case studies from Lusaka, Zambia; Nairobi, Kenya; and Gaborone, Botswana.

Security of Tenure

As the self-help school of thought points out, tenure security is the prime requirement for the success of self-help housing projects which these cases seem to have addressed but with a few discrepancies. Most of the beneficiaries of the projects were rural-urban migrants who seem to have moved to urban areas as a result of inadequate social services and in search of employment opportunities, but while investing in this project even though they are ensured legal rights to security they often desire more in terms of physical and social infrastructure services such as community schools, health centers, and other facilities for the survival of their families. These migrants were initially residing in illegal squatter settlements and slums because of its proximity to urban centers that offer these services, hence, they often imagine that to be the case when they were asked to resettle in areas with the promise of site and services. Tosics (2004) stresses the importance of sectoral policies in respect to housing management and maintenance, transport, infrastructure development, as well as, commercial and trade sector development from his study on housing and sustainable urban development in European cities. This brings us to a conclusion

that if all these requirements are needed to sustainably develop housing, compressed earth block technology can complement self-help housing in providing a feasible alternative to develop affordable housing on a large-scale in sub-Saharan Africa. In order to deliver on these objectives, time and cost efficiency plays a very important role.

Time efficiency is a prime feature in addressing tenure security as the transition with respect to site and services, including temporary and core shelters must be produced quickly. For instance, in the case of Gaborone, it was observed that plots were allocated at a seemingly slow pace for an average of five years. In the case of Lusaka, the legal system of land allocation was considered a bureaucratic maze incapable of fulfilling their needs. The use of CEB creates an environment to properly produce shelters with a reasonably swift timing that allows for beneficiaries in the self-help housing scheme to get going with their regular activities. One of the underlying reasons argued for the failure of housing policies to deliver on its objectives in developing countries is related to insufficiency in time. The technology requires little or no specialist skills, and it possesses advantages with respect to abundance in raw materials; and on-site production, thereby reducing time and transportation costs when produced on a large scale.

Also, tenure goes hand in hand with a level of trust in the system. Therefore, in order to get the beneficiaries to invest their time and money into the project and free them from the fear of illegality, they need to perceive a strong sense of involvement and security. Self-help housing projects need to be viewed as a valuable investment to the low-income beneficiaries over a long period of time, as the meaning of the word “tenure” implies. The housing structure produced with the use of compressed earth block technology is time- and cost-efficient when produced on the economies of scale, more so, providing a use and exchange value that beneficiaries can appraise as a commodity that could be valued on the market in the future. It could, in turn, address some of

the constraints observed from the housing projects ranging from default on loan repayments to the transfer of plots, since the beneficiaries are often laborers in the informal sector of employment with no resources other than their own labor and self-help resources.

In order to properly address the issue of tenure security in the future that incorporates the use of compressed earth block technology in self-help housing, the following recommendations are proposed:

1. Create proper documentation of land ownership and acquisition

There needs to be a system that properly documents any form of transactions involving land to create a long-standing trust of beneficiaries in the housing system. The existing legal framework of land policies in developing countries of sub-Saharan Africa could be perceived as bureaucratic as we observe from the case of Lusaka, hence, there is a need for the administration of departments to archive land data that allows information to be readily available to the beneficiaries, researchers, and practitioners, more importantly, built with a level of transparency and accountability. CEB production and construction requires soil from the earth, therefore there could be an inclusion of rights to soil extraction for a few years. Although the rights need to include regulations such as the depth of extraction, and number of blocks expected to be produced per volume of soil extracted to help prevent the misuse or abuse of extraction rights. The success of such regulations in CEB production depends largely on proper management through regular site inspections and record keeping.

Also, the case studies in this research focused largely on the site and service approach of self-help housing but there is a need for research on the in-situ development approach to self-help housing, which involves upgrading slums through self-help housing.

2. Limit regulations that are incomprehensible and impractical

The beneficiaries of self-help housing projects are often of the low-income cohorts, which means they are subject to a series of disadvantages and limitations. It is therefore important to put these into considerations when designing any regulations for CEB and self-help housing projects. In other words, regulations need to be flexible to accommodate problems that these group of people might encounter in the process of transition before they can fully adapt to the system. CEB technology is simple and flexible, making it easily extendable or altered in the future. For this reason, it reinforces the argument for self-help housing as embodying a potential for human creativity in seeking value in life.

The creation of basic design guidelines would allow households to expand easily over time but coming up with these regulations might require a study on the different types of households that reside in slums. The New Gournia village planned in the 1940s was largely successful due to the study done by the Egyptian Architect Hassan Fathy. His study allowed participants to include their actual needs into the design of houses, which could be of great potential in the use of compressed earth blocks. As Bredenoord (2017) says that the applicability of building materials is related to the power of individuals, households and resident groups, and the basic unit of self-help housing is a group, therefore, the study on how people live in slums can give answers to how households and resident groups form teams that can better cooperate together and help formulate various housing model typologies. The quality of CEBs is more important than the quantity produced as we found from the research, hence, maintaining a high standard on quality control of products with basic design guidelines would require proper management and random inspection.

One design guide could include encouraging high density in construction with shared courtyards per group of teams. For instance, a group of 3-5 teams consisting of 8 persons each

which we found to be the minimum number of crew to run a production line could be located around each other with the courtyard serving as a temporary CEB production area. These groups would rotate hours to work on the machine, allowing for maximizing time-efficiency. This kind of formation allows for easier shared waste and water management, and servicing of road network.

Affordability & Capacity of Individuals, Households, and Resident Groups

After examining the cases, it is evident that tenure security indeed is a prime factor for success in self-help housing projects but following that is the factor of affordability of building materials and construction which can be assumed to work concurrently with the capacity of individuals, households, and resident groups. When and if these both factors are appropriately addressed, it could arouse the willingness of entrepreneurs in self-help housing projects. It is self-evident that the unaffordability of housing is what led to the increasing number of people residing in slums and squatter settlements in the first place. Any project aimed at addressing the housing needs in sub-Saharan Africa must be affordable to the target population. It is important to take note of the fact that the target population, which is the low-income and marginal poor in the developing countries of sub-Saharan Africa, have various drawbacks ranging from unemployment to the lack of mortgage assets and a low level of literacy.

From the cases investigated, we observe that there was a preconceived notion that merely providing site, minimum services and material loans to the beneficiaries would simply make the projects affordable to them which ended up not being the case. This was made evident when the beneficiaries began to default on repayment of loans and adopt higher building standards. On the one hand, we can associate this to the rise in inflation, including the lack of administrative capacity to effectively monitor and enforce a comprehensive scheme, but when we see for instance the case of Gaborone, the number of initial beneficiaries who transferred their plots then we begin to

question the stipulations. Self-help housing as Turner argued from his study in the 1960s found that households improved their settlements incrementally using better materials and adding space over the course of 15 years. Now the question here is if the high cost of building materials, coupled with the rise in inflation costs might have played a big factor in the failure of these projects. If yes, then it is time we tie self-help housing projects to the importance of affordable building materials which brings the compressed earth block technology to the unveiling. The technology is affordable when produced on a large-scale and, time and cost-efficient for matching the capacity of individuals, households, and resident groups through its simplicity and flexibility.

Furthermore, the level of community participation in the projects was largely limited to unskilled labor and the decision-making process for the project but if we observe the arguments for self-help housing closely, the idea is to build better inter-communal relationships through partnership and participation. This would, in turn, build a sense of mutual ownership and trust in the housing system. As we can see from the examined cases, the self-help concept faced challenges such as the high cost of construction which we believe CEB could address. On the other hand, the lack of adequate expertise was a major drawback in involving beneficiaries in taking on the aspect of skilled labor in various projects. Compressed earth block technology requires little or no specialist skills, creating an opportunity to train workers for the construction industry especially in sub-Saharan Africa where little or no technical background might already exist among these targeted beneficiaries. The technology allows for a genuine involvement of low-income and poor families in almost all aspects of the building project, in turn, leading to the generation of wealth on the housing market. In addition, beneficiaries can make their contributions in the form of labor and sweat equity to catalyze their creativity in seeking value in life. In other words, the vocational training would spring forth an inflow of capital and utilize the vast human resources of the

beneficiaries, unlocking the existing underutilized human capital in developing countries of sub-Saharan Africa.

3. Incorporating diverse credit and financing mechanisms

There is a need to consider the financial limitations of the low-income. This would require a long-term comprehensive approach to allow for a reasonable and feasible payback time on material and construction loans, incorporating a rise in the inflation value over the set period. Also, the regulations set in terms of asset requirements need to be relaxed or systematically reviewed to allow alternatives for interested groups. Allowing a feasible time on payback on loans would increase social stability that help increase economic and environmental stability. This recommendation is tied with the next which is the creation of workshops and vocational training schools to teach compressed earth block making to individuals and households. For instance, according to Williams (2005) self-help provides families with an opportunity to generate wealth in basic way which could allow for credit institutions to multiply this wealth and offer generation offspring to build on the works of their previous generations.

4. Create workshops and educational programs to train artisans

This is important to address many low-income beneficiaries who are unemployed and have a vested interest in participating fully in the construction of their houses. Training groups in making compressed earth blocks would allow for homogeneous viable structures across all self-help housing projects that incorporate the use of the technology, as well as, creating an employment market in the construction industry. On the other hand, it could be coupled with other forms of vocational skills that would allow for beneficiaries to acquire capital and wealth through learning of craft which could, in turn, result in an export-driven economy. The Kampung Improvement

Project experimented in Indonesia by the World Bank provides an example of a framework for “Learning by Doing”.

It is not a fantasy to see cities built of compressed earth blocks through self-help housing. For instance, if 2500 blocks can be produced in a day from one machine, then we can presume that if all things being equal 75000 CEBs can be produced within a month. If this number is extrapolated within a year, we can imagine how many houses is produced from a single block machine. The vocational training school could tutor other vocations like agriculture, trading, artistry, plumbing, tailoring, among other courses that would help reinforce the informal employment sector of the economy. The vocational training has the potential for creating intentional communities that are built on a high degree of social cohesion and teamwork.

5. Increase community participation and benefits for beneficiaries

More so, there is a need to increase the level of participation of community members or beneficiaries involved in the project to maintain a strong sense of mutual ownership. If we look at the case of Singapore where the Central Provident Funds (CPF) was used as an instrument to ensure payback on loans, it played a major role in building the capacity of its beneficiaries through increased competition and incentives to work but we need not underestimate the role of the benefits given beneficiaries via the use of scholarship and grant schemes, including education schemes and tax benefits. The analysis made in the recommendation above tells us how much CEBs can be manufactured in a year, therefore, increasing community participation would increase competition and efficiency in time and cost along with a level of motivation that go back in reinforcing tenure security of households.

Sustainability in Social Organization

It is not enough to simply deal with the above-discussed factors, without figuring a sustainable form of organization to make the project work and preserve it over the long run. Let's take for instance the case of Lusaka where an emphasis was made on participation far beyond its economies of scale or self-help strategy. The basic unit of any form of organization in self-help is the group. It is vital that organizing this group sustainably is not overlooked, as this would build the collective sense of ownership. From examining the cases, they fall quite short of this standard which could be associated with the lack of a comprehensive guide to address maintaining an organized group or lack of enough administrative capacity to monitor the project over time. Sustainability here goes beyond dividing the beneficiaries into groups of 15-25 as observed from the cases, rather the question should be how these projects can maintain this grouping, giving respect to their individual strengths and shortcomings. In the case of Nairobi, the mutual financial assistance could be perceived as sustainable because it provided an instrument which catered for the financial drawbacks of its group member. On the other hand, we find some discrepancies in answering the question of whether these grouping numbers of 15-25 was on advantage or disadvantage. Also, there were no available records of how these group members worked together in terms of working hours or the noted strengths, weaknesses, opportunities and threats encountered through the several teaming methods employed.

Compressed earth blocks might not be a direct answer to resolving this issue of sustainability, but the available literature points out that it is cheap, flexible, and useful in providing minimum standards and a suitable supply of building materials over time.

6. Encourage minimum number on a team to work with CEBs

In order to sustainably maintain a group which is the basic unit of self-help housing, it is important to keep the number at a reasonable minimum. From reviewing the literature on CEB, we found that working on a production line requires a team of about 8 people. Therefore, grouping a small number of 3-5 teams as suggested earlier could help maintain better quality control in the production of the blocks, thereby keeping unforeseen group conflicts at the minimum. An advantage of this type of grouping is the ability to rotate working hours, as well as, promoting time- and cost-efficiency in large-scale production of affordable self-help housing. Also, this allows for better overall management and team working, including keeping the level of group dependency at the minimum.

Although working with compressed earth block technology is labor-intensive and requires heavy work, construction could be phased to suit both weather conditions and availability of helpers, thereby creating the potential to serve as a complement to the power of self-help housing as is in the words of the UN-Habitat:

“... the most affordable and intelligent way of providing sustainable shelter. It is cheap because it is based on minimum standards and incorporates a substantive amount of sweat equity. It is useful because individuals and communities engaged in it acquire precious skills. It is practical because it responds to people’s actual needs and levels of affordability. It is flexible because the dwelling units are often designed to be able to expand over time. But all construction and particularly incremental upgrading requires a suitable supply of building materials, components, and fittings”

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