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0. Abstract

The focus of research on Energy for Low Income Tropical Housing is low-income housing in the tropics, a category of building that houses over 1 billion people in 3 continents, some of them very poor. Anything that lowers the cost or increases the security of supply of such dwellings makes a contribution to poverty alleviation. Reducing the energy required to construct or operate houses has, in the context of rising energy prices, a role in reducing costs. The research aims to identify and confirm premium ways of achieving such a reduction. Before going deep into energy issues it has been important to highlight challenges in the housing sector and some of the problems solutions suggested. The paper recognizes important players in the housing sector and their contribution have been brought forward. The paper also brings forth the future issues which need concerted efforts by stakeholders. The paper ends with conclusions and conclusions which can be taken up by policy makers and other important sector stakeholders.

1.0 INTRODUCTION

Tanzania has an estimated population of 47.4 million as of 2014. With the support of the various development strategies which include the National Strategy for Growth and Reduction of Poverty (NSGRP) popularly known as MKUKUTA and the Five year Development Plan 2011-2015, Tanzania has been able to make important economic and structural reforms and sustain its economic growth rates over the last decade.

Nevertheless, poverty is still widespread, and given Tanzania's position as a net exporter of gold and a net importer of oil, without heavy industrial investments, the economy is not immune to external shocks, a situation which continue to have a bearing on housing development because of the bulk of building materials, equipment and expert personnel still have to be imported from abroad at exorbitant prices and taxation.

The housing need in Tanzania is estimated to be 3 million units with annual increase of 300,000 units (Shelter Afrique). The existence of house deficit is very high with consideration of the quality of houses and congestions in line with important services like water and electricity. Taking these factors into consideration, the housing deficit in urban

Tanzania is estimated to be 1.2 million units, of which 36% are in Dar Es Salaam. Moreover, income levels of most households in Tanzania are too low; 90% of population can afford less than \$45 and 68% can afford less than \$23 on housing per month (Housing Market Study, Tanzania, 2012). Financing, though relatively increasing, is not affordable to most households. It is estimated that only 3% of the population can afford a mortgage. In this view, it is estimated that demand for housing microfinance in Tanzania exceeds \$400 million (Market Study on Housing Microfinance, Tanzania, 2012). According to UNICEF (2011) only 46% of population has access to safe drinking water. Most houses have no registered title deeds.

2.0 CHALLENGES IN THE HOUSING SECTOR

2.1 General Features

According to the Household Budget survey main report of 2011/12, on average 60.6% of households in Tanzania are constructed with earth floors, with non-durable walls was 51.8% and those with non-durable roofs were over 50%. At the same time, previous research reveal that the housing requirement for the country in the next 10-15 years is estimated at 2,000,000 units in urban areas and about 7,000,000 units in the rural areas. The situation poses a big challenge to those involved in affordable housing delivery services for low income earners.

According to the available information the current housing deficit in Tanzania is about 3 million units, the annual growth demand being around 300,000 units. The problem is pronounced in urban areas where the population growth seems to go on increasing day by day. This has been found to be compounded by rural-urban migration, natural population growth and uncoordinated efforts in housing delivery. Due to economic and political reasons, population exodus from villages to urban areas and other places like the mines has been taking place in Tanzania in the past 50 years. This event coupled with population growth has given the housing problem a gigantic proportion.

If countries have to expand their housing stock for the continuously growing population, they will have to identify the least costly solutions, in terms of cost per housing unit. Furthermore, these solutions should be flexible to allow for new materials and technologies.

In East Africa, the urban population will climb from 77 million in 2010 to 337 million in 2050. While East Africa is still predominantly rural and will remain so for some time, the region is expected to experience total and urban growth rates higher than the African average for the foreseeable future. Unfortunately, East Africa's rapid urbanization is due to a "widespread poverty-driven economic survival strategy," rather than severely needed economic expansion. However, with urban populations growing faster than the urban economies, the wisdom of seeking economic survival in the largest cities has become doubtful. Stress on urban housing supplies can only be expected to deepen further amid systemic institutional failures that perpetuate social exclusion and inequalities between the urban poor and rich.

Urban growth rates in Tanzania, which are pegged at a rate of 3% to 5% over the next forty years, continue to outpace the global average. Dar es Salaam, Tanzania's commercial capital and primate city, is one of the world's ten fastest-growing large cities. Already failing to deliver housing and basic services to its urban poor, the Tanzanian government will have to make strategies to catch up in the coming decades.

The housing challenge for Tanzania and other developing countries can be sorted out in two categories, namely rural context and urban context. Despite the abundance of resources in rural areas, there is still hardly an attractive housing in rural areas to date except for some few villages. Urbanization is taking place even in rural areas and some of the villages are fast growing to become urban centres. The same applies in some urban areas especially those places where the low income population live. This paper highlights the kind of housing situation found in many rural areas as well as in urban areas.

In general terms there is a difference between rural area challenges and urban area challenges. Housing challenge in rural areas is not that of ownership of a dwelling unit but mainly of quality, while in urban areas the main challenge is the accessibility to a decent dwelling unit whether owned or rented especially for low income earners. Table 1 below shows ownership status of dwelling units in rural and urban areas for the case of Tanzania.

Table 1: Percentage of Households by Ownership Status of the Main House, Tanzania Mainland, 2012 Census

	Total No. of Households	%						
		Owned by Household	Living without Paying any Rent	Rented Privately	Rented by employer	Rented by government at subsidized rent	Owned by Employer (Free)	Owned by Employer (Rent)
Total	9,026,785	74.3	4.2	18.6	0.8	0.8	1.0	0.3
Rural	6,054,641	87.8	4.0	6.3	0.5	0.4	0.9	0.2
Urban	2,972,144	46.9	4.7	43.6	1.5	1.7	1.1	0.4

Source: Tanzania Mainland- basic Demographic & Socio-economic profile 2014

2.2 Housing Challenges in Rural areas

The prevailing housing conditions in many regions, districts, wards and villages today in Tanzania still leave a lot to be desired. Construction of rural houses is still based on self-help and community-help approaches particularly when traditional housing technology is concerned. In many parts of Tanzania, traditional housing is still prevalent which uses organic building materials and from earth in form clay, sand, gravel and stone.

A bulk of the construction in the rural areas is done with materials such as bamboo, timber, round pole, straw, grass and mud or adobe and many of which are used directly without being processed for their quality improvement rendering them for attack by climatic conditions and vermins which shorten their lifespan to less than five years. The houses so built with this kind of materials are of poor quality, short lifespan, and requiring repair after almost every season, which interferes with other economic activities. However, due to population increase with subsequent overexploitation, such materials are also becoming scarce at their sources, which requires builders to fetch them at long distances. This challenge, coupled with poor construction skills has rendered poor housing in rural areas.

2.3 Problems of rural housing are attributed to various reasons.

The problem of housing in rural areas is not of availability but of quality. In most villages, the youth, who are in the prime working age have migrated to urban areas living behind the elderly,

the disabled and the children. There is therefore a gross inability and unavailability of the productive workforce who can contribute to the provision of decent housing. These people in rural areas lack technical skills on the choice and use of available building materials but also they don't have construction skills. There is also no supporting infrastructure for hauling of materials at large distances. Climatic conditions and weather dictate on the durability of building materials in use. Naturally occurring materials of organic origin normally do not withstand attacks from weather conditions of rain and adverse weather changes rendering them to rot and digestion by vermins like termites and rodents.

Some other factors which contribute to poor housing in rural areas include cultural norms, attitudes and prioritization on good housing vis a vis others like polygamy in some communities. Others are still upholding on their traditional ways of life which if not adjusted, the 21st century dynamics will cause them to be left behind. These include pastoralism and lack of exposure to posh, clean and higher standard living environments.

2.4 Housing Challenges in Urban Areas

Tanzania's level of urbanization of 29.1% in 2012, (up from 5.7% in 1967) is relatively low (URT 2006), but growing at 5.2% per year, urban population is growing among the highest in Africa (URT 2013). At this rate, Tanzania's urban population is expected to reach 50% of the total by 2030. This growth, which is largely fuelled by high rates of rural-urban migration, occurs in the form of densification of the major cities, lateral expansion mainly in informal settlements and growth of rural trading centres. A survey conducted in 2015 reveals that 61.4% of the urban dwellers migrated from rural areas against 38.6% who are born in urban areas.

The urban poor people in most developing countries have posed another type of housing problem. The nature of the problem in urban areas is different from that in rural areas. Some of the house construction types of rural areas cannot be permitted in urban areas especially in planned areas. At the same time, low income people cannot afford conventional modern houses, constructed on well-arranged planned areas.

Examples of squatters in urban areas (in pictures)

2.5 Problems of urban housing are attributed to various reasons:

The problem of urban housing looks more complex than that of rural areas. The burgeoning population growth from rural to urban migration does not go proportionately with the availability of employment opportunities and accommodation. In this situation many youths find themselves stranded in a hopeless situation with neither employment, reasonable income nor suitable accommodation. Increased numbers of unemployed youths in overcrowded squatter areas has led to another social challenge on law and order with criminal occurrences keeping on increasing due to inadequate employment opportunities as the burgeoning population in towns and cities does not match with economic engagement opportunities.

Even if one has an income and savings for housing construction, there is an endemic lack of surveyed plots which can be allocated to individual home builders. Moreover, building materials in urban areas are sold at prohibitively high prices and out of reach of the low income dwellers. There is also an uncoordinated system of housing delivery on the part of various actors of the industry who include the central government, the local government, investors, financiers, non-government organizations and individual builders. The high prices of building materials has led to unaffordability of conventional housing on the one hand, and to mushrooming of squatter areas around town, municipalities and cities because of lack of surveyed plots on the other.

Rapid growth of population in cities and towns, has led to overcrowding in dwellings especially for the low income people largely compounded with large populations flocking to towns for better jobs and community service facilities. Poor conditions of service infrastructure and basic services of water and sanitation pose another challenge of health wellbeing of populations involved, particularly the low income areas and in squatter areas. These people are exposed to hazardous living conditions of poor sanitary environment due to inadequate liquid and solid waste disposal management systems. The situation is compounded as it is these same people who are deprived from access to other social

services like insured medical services and they have no financial ability to foot the bills especially when endemic diseases like cholera break out.

3.0 ACTORS IN THE HOUSING SECTOR

3.1 Government Institutions

The limited amount of housing construction is largely done by the public sector either through the National Housing Cooperation (NHC), the Tanzania Building Agency (TBA), which caters specifically to the government employee market or through the parastatal pension and social security institutions. The private or “organized” developer/ builder market is virtually absent in Tanzania and there is no professional real estate developer associations. The little private development which does occur tends to be luxury developments aimed at the wealthy, expatriates or the Diaspora. Reasons given for lack of real estate developers are (i) lack of access to finance (ii) lack of technical and managerial capacity in real estate development sector and (iii) the high cost of using imported materials and (iv) the lack of provision of basic services and infrastructure by local authorities. Developers are then forced to develop their own solutions, which inevitably raise the price of houses significantly.

The government also established capacity building institutions such as the national housing and Building Research Agency (NHBRA) and other higher learning institutions which contribute in increase knowledge in housing matters in the country through research and dissemination. NHBRA is a specialized institution in research and development in housing, building materials and building technologies.

3.2 Non-Governmental Institutions

There has been a rise of private developers in housing delivery these days, mainly composed of individual investors and real estate development companies. On the other hand, there are some civil society organizations who serve their members with soft mortgage conditions for building their houses on communally obtained plots. Such are the Centre for community Initiatives (CCI) who work with the Homeless International and WAT Human Settlements who work with Rooftops Canada. Private individuals who build with their own savings still contribute a significant housing delivery of 70% of all housing units.

3.3 The Rise of Mortgage Market

The mortgage market has continued to grow steadily, recording an annual growth rate of 59% in early 2015 (with a growth rate of 23% recorded only in the last quarter of 2014). 19 lenders are now offering mortgage products with more due to enter the market. The ratio of outstanding mortgage debt to Gross Domestic Product (GDP) stands at less than 1% which is very low. High interest rates and lack of affordable housing remain the major constraints on market growth. Key players in the mortgage market are the banks. Several banks have joined in the lending services to house builders and developers. These include Equity Bank Tanzania Limited, Azania Bank Limited, Stanbic Bank (T) Ltd, Commercial Bank Of Africa (T) Limited, Efc Tanzania M.F.C Limited, CRDB Bank Plc, Barclays Bank (T) Limited, and KCB Bank Tanzania Limited. The government formed the Tanzania Mortgage Refinance Company (TMRC) to facilitate mortgage loans to lending banks but not to lenders directly.

Table 2: Key actors in the development of shelter in Tanzania

	Actors	Contribution
1	Individual unsurveyed Dwellings	70.0%
2	Individual Surveyed Dwellings	13.5%
3	National Housing Corporation	5.1%
4	Real Estate Developers	3.9%
5	Central Government	3.0%
6	Pension Institutions	2.4%
7	Local Government	2.1%

Source: (Nkunduma, 2009)

4.0 SOLUTIONS TO THE CHALLENGES

4.1 SOLUTIONS TO THE CHALLENGES FOR RURAL AREAS

Table 3: Proposed Solutions for Challenges in Rural Areas

S/N	HOUSING CHALLENGE	POSSIBLE SOLUTION	PROPOSED ACTOR
1.	Lack of technical skills and knowhow on the choice and use of building materials;	Conduct training to rural artisans and technicians	Research institutions e.g. NHBRA, technical institutions,
2.	Lack of building and construction skills	Conduct training to rural artisans and technicians	Research institutions e.g. NHBRA, technical institutions,
3.	Lack of supporting infrastructure especially for hauling of materials at large distances	Improve transport and communication infrastructure to rural areas	governments
4.	Climate and environmental conditions which dictate on the design and affect the materials;	Materials improvement e.g. stabilization, preservation etc.	Self-help builders,
5.	Economic activities e.g. pastoralism	Train communities on modern methods of animal husbandry	Ministry of Agriculture and livestock, media
6.	Lack of exposure of good living conditions	Expose communities to see and learn about improved lifestyle from other places	Media, civil society organizations;

4.2 SOLUTIONS TO THE CHALLENGES FOR URBAN AREAS

Table 4: Proposed Solutions for Challenges in Urban Areas

	HOUSING CHALLENGE	POSSIBLE SOLUTION	PROPOSED ACTOR
1.	Lack of surveyed plots for individual homebuilders	Ensure proper land use plan in all sub urban areas potential for development	Governments (Ministry of Lands & Ministry of Local governments
2.	High cost of building materials out of reach of many people	Establish local building material processing factories	Governments & Private sector investors
3.	Lack of a coordinated system to provide housing to the fast growing population of urban dwellers	Have good and implementable policies on affordable housing	Governments, estate developers, civil society organizations
4.	unaffordability of conventional housing and mushrooming of squatter areas around town municipals and cities	All sub urban areas to be planned and protected	Local authorities
5.	overcrowding in dwellings especially for the low income people	Make affordable housing accessible to	Governments, civil society organizations

		low income people at a subsidized price	
6.	hazardous living conditions of poor sanitary environment due to inadequate liquid and solid waste disposal systems in squatter areas	Provide essential infrastructure to all squatter areas in existence	Governments and infrastructure Service providers
7.	criminal occurrences due to inadequate employment opportunities in urban areas	Provide employment opportunities	Governments, investors

4.3 SOLUTIONS TO THE GENERAL CHALLENGES

Table 5: Proposed Solutions for General Challenges

	HOUSING CHALLENGE	POSSIBLE SOLUTION	PROPOSED ACTOR
1.	Rural to urban migration	Strengthen basic services in rural areas	Governments and investors
2.	Lack of guiding policies, laws, regulations and legislations on affordable housing	Institute the necessary legislations on affordable housing	Governments and civil society organizations;
3.	Reduce embodied energy and carbon emission from construction, demolition from the expected construction boom	Promote low energy and environmental friendly technologies for affordable housing	Governments, civil society organizations, investors, service providers
4.	Reduce operational energy and carbon emissions from households	Promote appropriate architectural designs and practice climatic design of urban areas,	Designers and regulating authorities,

5.0 FUTURE ISSUES IN THE HOUSING SECTOR

As years go by, rapid urbanization accompanied with deepening poverty, environmental degradation and increasing slums, will continue to challenge the efforts to provide shelter for all. Rapid urbanization in the developing world is the most unprecedented phenomenon in the world's development in the past few decades. The pace of urbanization has and will continue to exceed the capacity of cities and governments to absorb the needs of a growing population, despite all innovations and efforts by the actors in the housing sector. One of the pressing problems is the provision of adequate housing for all especially the low income population (UN-HABITAT 2008). Urban population will continue to grow while economic capacities do not cope in terms of housing and urban services provision.

Land ownership being at the root of the challenge, squatter areas and slums will continue to part of the feature of the rapid urbanizing cities. For example in Dar es Salaam, the 10th fastest growing urban centres in the world, 70% of the population lives in unplanned areas. The situation seems to be the same as in other major cities of the developing world. On the other hand, land is becoming

scarce due to overexploitation and overuse due to population explosion. As a result low income people' accessibility to land ownership becomes difficult day by day. Scarcity of land, will likely force housing delivery actors to go multi-storey in order to preserve land at exorbitant prices beyond the affordability level of the low income people.

There is a likely increase in economic activities as the population increase including housing construction, demolition and replacement of old houses in both rural and urban areas, employing enormous amounts of embodied energy, operational energy, and carbon emissions with subsequent damage to the environment. Unless sustainability measures are instituted by governments with a push from the private sector and civil society. This is also likely to go out of hand as many governments have not been able to have proper policies, laws, regulations and legislations to control indiscriminate use of natural resources and even for adopting newly developed environmental friendly technologies. The consequence is a continued use and enforcement of old and outdated legislations which are uneconomical especially for the local income people

Estimation of Embodied energy and carbon for different sizes of dwellings to be promoted. Table 2 below shows that construction of low income houses will have a significant contribution to the overall energy consumed and carbon emissions in the aggregate economic activities in the country.

If in one way or another, the housing demand of 300 units per annum, is met somehow the resulting embodied energy is enormous. So it is important to use low energy materials in construction.

Table 6: Summary of Embodied Energy and Carbon in Construction Stages for 3 selected models

House Model No.	Category	Floor area (m ²)	Burnt Bricks		Sand – Cement Blocks		Interlocking Bricks	
			Embodied Energy (MJ)	Embodied Carbon (KgCO ₂)	Embodied Energy (MJ)	Embodied Carbon (KgCO ₂)	Embodied Energy (MJ)	Embodied Carbon (KgCO ₂)
1.	Rural	26.235	99,282.91	7,701.73	85,392.09	8,390.8	76,400.39	6,728.08
		1 m ²	3,784	294	3,255	320	2,912	256
2.	Sub urban	69.5	262,988	20,433	226,223	22,240	202,384	6,784
3.	urban	102.4	387,482	30,106	333,312	32,768	298,189	26,214

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

- (a) The challenge ahead is how to match housing development with demand especially created by high rate of urbanization. Therefore the provision of adequate and affordable housing in urban areas is one of the most pressing challenges facing Tanzania at the moment.
- (b) Most housing challenges in affordable housing delivery are caused by the lack of appropriate policies and the corresponding legislation frameworks. It is envisaged that if governments provide a conducive environment, the housing sector has every potential as one of the most popular economic sectors;
- (c) Energy for low income tropical housing is a new concept in many developing countries, even to those who were trained in energy analysis. There is a close relationship between embodied energy in construction and construction cost. Embodied energy would be an important yardstick to check the viability of any construction technology;

6.2 RECOMMENDATIONS

- (a) Although mortgage finance is at times unaffordable to many low income groups, it is still recommended to sensitize communities to use such services even if it means to use other means such as housing microfinance, housing cooperatives, SACCOSS, or VICOBA
- (b) Governments through Ministries responsible for housing should assist Local Authorities to establish Housing Departments in their councils and extend the same to lower levels so as to sensitize communities on decent housing.
- (c) Dissemination of low energy and environmental friendly technologies should be implemented for builders, building materials manufacturers, professionals and policy-making agencies, via demonstrations, training, changes in networking and publication;
- (d) Sustained and collaboration of countries in these areas should be encouraged. NHBRA has several such technologies which have been proved to be suitable for sustainable housing in both rural as well as in urban areas. Such technologies are such as mortarless walling using Interlocking soil stabilized bricks, span flooring technologies using laadies and waffles, roofing tiles with associated equipment and moulds;

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