

DRAFT REPORT

A REVIEW OF THE NHBRA OPERATIONS ON THE DEVELOPMENT AND PROMOTION OF AFFORDABLE HOUSING PRODUCTS

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Abbreviations and Acronyms

AU	African Union
AQRSB	Architects and Quantity Surveyors Registration Board
BRU	Building Research Unit
CBO	Community Based Organisation
CCI	Centre for Community Initiatives
CEB	Compressed Earth Blocks
CoET	College of Engineering and Technology
COSTECH	Commission of Science and Technology
CRB	Contractors Registration Board
DIT	Dar es Salaam Institute of Technology
EPS	Expanded Polystyrene
ERB	Engineers Registration Board
FGDs	Focus Group Discussions
FRC	Fibre-reinforced Concrete
LAPF	Local Authority Pension Funds
LGAs	Local Government Authorities
IBPM	Interlocking Bricks Press Machines
ICT	Information and Communication Technology
M & T	Materials and Technologies
MLHHD	Ministry of Lands, Housing and Human Settlements Development
NCC	National Construction Council
NCR	National Council for Research
NEPAD	New Partnerships for African Development
NHBRA	National Housing and Building Research
NHC	National Housing Corporation
NSGRP	National Strategy for Growth and Reduction of Poverty
NSSF	National Social Security Funds
PESTEL	Political, Economic, Social, Technological, Legal and Environmental
PPF	Parastatal Pension Fund
RE	Rammed Earth
REPOA	Research on Poverty Alleviation
SIDO	Small Industries Development Organisation
SWOC	Strength Weaknesses Opportunities and Challenges
TBA	Tanzania Building Agency
VETA	Vocational Education Training
WAT-HST	WAT – Human Settlements Development Trust

Executive Summary

The National Housing Building and Research Agency (NHBRA) came into being in 2001, following the government decision to transform the former National Housing and Building Research Unit (NHBRU), into an executive agency. Whilst the mandate of NHBRU was to research on appropriate and low-cost building materials and technologies all over the country, NHBRA, has been assigned additional mandate. This includes improving the standards of human shelter by advising and promoting appropriate local building materials and technologies for affordable and durable housing. In this respect NHBRA is required to research, develop building materials and technologies and provide advisory services on different ways to improve housing in Tanzania, with an emphasize on affordability, durability, standard hygiene, comfort and convenience and capacity building. This study, aimed at conducting a review on NHBRA operations in relation to development and promotion of affordable housing products.

In an endeavour to achieve this, over years, NHBRA has developed and promoted various products that include building materials, such as interlocking soil cement bricks and sisal fibre reinforced concrete (FRC) roofing tiles; NHBRA has also promoted equipment used for production of bricks and FRC roofing tiles. This includes press machines for interlocking bricks (IBPM), vibrators and moulds for roofing tiles.

Analyses of data and information collected from various sources have invariably confirmed that NHBRA has and continues to play a critical role in research, innovation and dissemination on non-conventional and affordable building materials and technologies. However, despite the achievements so far and reforms undertaken by the government to improve the status and performance of NHBRA, overall, the impact of NHBRA operations since its establishment remains limited.

The major issues emerging from the study

As the SWOC analysis depicted there are more constraints than strengths and opportunities, making NHBRA unable to deliver in accordance with its mission and core functions.

(i) Through the skills gained and the use of NHBRA materials and technologies, the urban poor living in formal and informal settlements have accessed improved and affordable houses. Some of the key features which make NHBRA products attractive include the economies of the materials and technologies; the modest skills required to adopt them; and most importantly the high potential to use and or adapt the available local materials and technologies.

(ii) Despite the aforementioned limitations NHBRA has and continues to play a critical role (albeit modest) in research, innovation and dissemination on non-conventional and affordable materials and technologies. Over the last five years more than ten construction

projects related to affordable building materials and technologies have been undertaken. Besides, over 3,002 persons were trained between 2004/05 and 2009/10. This includes many women who were trained by NHBRA; and have in turn successfully implemented housing schemes in Dodoma and Morogoro.

(iii) It has been confirmed that raw materials for the products innovated by NHBRA are in most cases abundantly available locally, that is, within or closer to the areas where affordable homes are desperately needed.

(iv) The economics of the materials and technologies, the modest skills required to adopt or be able to use them and most importantly, the high potential to adapt the subsisting locally building materials and technologies are key attributes that make the building materials and technologies innovated by NHBRA not only attractive, but also responsive and appropriate for expediting realization of the Housing Finance Project.

(v) NHBRA products are likely to have a large market, particularly because of the huge unmet housing deficit especially for low and middle income groups. The potential to lower costs of the housing, through self-help initiatives and on-site making of building materials such as bricks and roofing tiles are also critical attributes. Needless to add, housing requirements are also likely to increase significantly in the coming years, primarily because of high population growth rates.

(vi) Housing is increasingly becoming an agenda in the government policies and plans. A number of public institutions such as NHC, PPF, TBA, Watumishi Housing Agency and NSSF, are aggressively exploring and pursuing options to deliver affordable housing especially to low-income households including public servants. The demand of NHBRA materials and technologies is therefore likely to increase among middle income group also.

(vii) One of the major drawbacks is the failure of NHBRA to tap the abundant potential of alternative building materials available in various places in the country.

(viii) NHBRA is highly handicapped as it presently lacks modern and heavy duty equipment for research. For instance, at time NHBRA uses the laboratory facilities at the University of Dar es Salaam to test heavy duty building materials.

(ix) The documentation and dissemination of materials and technologies innovated by NHBRA is overall poor. The documentation system is largely manual and information poorly managed. Besides, the current modes of documentation and dissemination of

NHBRA materials and technologies are not easily accessible or user friendly. Consequently, in most cases, there has been little use beyond the specific project areas.

(x) NHBRA is unable to upscale the use of its materials and technologies inter alia because of resource paucity (e.g. shortage of financial and manpower) and poor link with the private sector, especially large scale producers of building materials and prospective home- builders. Poor marketing strategy is particularly a weak link in the NHBRA product promotion chain.

(xi) There is also a weak institutional inertia and strategy to transform in line with the changed socio-economic and political environment in the country. This, coupled with inadequate local capacity building in the areas and project sites (and areas adjoining them) has led to slow diffusion and poor adoption of NHBRA materials and technology.

(xii) Low visibility of most demonstration projects built by NHBRA in especially up-country is also a handicap. This means that very few of the would-be home-builders are informed or aware of the low cost and affordable, but good quality materials and technologies innovated by NHBRA.

(xiii) NHBRA does not have a mechanism to make follow-ups on how their products are performing or whether or not their clients are satisfied. The point here is that for a research institution such as NHBRA, the challenge is not only to produce innovative affordable products, but to also monitor customer satisfaction, changing perceptions and challenges emerging during the lifetime of the product.

(xiv) NHBRA has directly and indirectly collaborated with a number of public institutions including TBA, NHC, GPSA, and VETA as well as with NGOs, such as CCI and WAT-HST. The collaboration, with these organizations is however not institutionalized.

(xv) The current piece of land measuring 2.29 acres that accommodates NHBRA at Mwenge in Dar es Salaam is too small given the anticipated expansion of NHBRA activities in future.

(xvi) NHBRA materials and technologies have high potential to contribute towards the realization of the objectives of the Housing Finance Project, especially promotion of affordable housing. However, at present it does not have the requisite capacity to fulfil this very critical noble role.

Recommendations

The recommendations presented here are structured along the key study areas defined in the ToR and issues that emerged from the empirical studies. In order for NHBRA to be able to play a leading role in the housing delivery project, there is therefore a need to take immediate actions to address the concerns.

Short and medium term Recommendations are made to:

Short term

(i) Improve the documentation system by rehabilitating the current library. This also includes modernization of basic library equipment and facilities such as computers, furniture, photocopiers, scanners etc. It also involved acquisition of a bigger room for the library, scanning and word-processing so that they are available on-line.

(ii) Embark on aggressive marketing programme. This includes the need for preparing a marketing plan and strategy as well as development of the Website and uploading of relevant documents.

(iii) Develop a strategy to enhance public awareness creation about their products and availability of raw materials that are affordable in various parts of the country. It is particularly important to carry out public awareness campaigns necessary to fight attitudes which tend to associate NHBRA products with substandard or poor quality materials and technologies.

(iv) Take immediate action by NHBRA to formalise with peer organisations and research institutions especially those engaged in building materials and technologies. The formalisation includes establishment of memorandum of understanding (MoU). In this regard it is further recommended that NHBRA should also take a leading role in establishing a formal forum or platform of key stakeholders involved in building materials and technologies.

(v) Future expansion of NHBRI at its present site in Mwenge is highly restrained particularly because much more office space for laboratories and outdoors exhibition areas will be required. In addition NHBRA does not have branches upcountry. It is therefore **recommended** that NHBRA takes immediate action to search for and acquire adequate land within and outside Dar es Salaam for future relocation and expansion.

(vi) Forge working partnership with VETA, SIDO and Folk Training colleges. These institutions have a wide network as well as branches, distributed in many districts and regions. These could therefore play an important role not only in training but also in disseminating NHBRA materials and technologies.

Medium term

(i) Transform NHBRA from a government Agency to a semi-autonomous Research Institute. This includes restructuring of some of the existing units, establishment of a governing board, recruiting new staff and establishing an operationalising research policy.

(ii) Introduce a new levy on all producers and distributions of building materials and technologies. The latter is necessary so as to provide a sustainable source of financing to fund research, documentation and dissemination (including public outreach) activities of the proposed Institute.

(iii) Intensify collaboration with other partners and solicit the private sector support to engage in mass production of some of innovated technologies, especially those which have attracted good market such as interlocking soil-cement interlocking bricks.

Chapter One

Introduction

1.1 Background

Housing is a basic human need and also a critical source and driver of economic growth. It also directly contributes towards enhanced social security, health and human dignity. Investments in housing contribute directly to national capital formation and labour productivity. In this respect, access to affordable housing also lies at the centre of poverty reduction and equitable socio-economic development. Therefore, the housing sector can constitute a tool to stimulate economic growth (URT 2013). Studies estimate that the current housing deficit in Tanzania is about 3 million units, the annual growth in demand being 200,000 units. In monetary terms, the deficit, annual and growth in demand are equivalent to US$ 180 billion and US$ 12 billion respectively. It is apparent that this offers a critical opportunity to the national economy, creation of jobs, increased revenues, financial sectors growth etc. However, despite this potential, the housing sector contribution to GDP is less than 0.1 percent (URT-UNESCO, 2009). The government plans to increase the contribution to 4 percent.

The government has for a long time recognized the role that housing plays in socio-economic development and general well-being. For instance, it has embarked on a number of programmes, plans and activities which aim to promote housing for all social groups. These include:-

(i) The provision of specific clauses on housing in the first and second Five Year Plan for Social and Economic Development (1960s and 1970s);
(ii) The establishment of the National Housing Corporation (NHC) in 1962;
(iii) The establishment of the Building Research Unit (BRU), now the NHBRA in 1971; and the conduction of the *Nyumba Bora* campaign. The *Nyumba Bora Campaign* focused on the promotion and use of low-cost materials and technologies and
(iv) The establishment of the Tanzania Housing Bank (THB) in 1973.

Whilst individual households have been the major producers of housing units in the country i.e. over 95 per cent, the existing housing stock and despite the numerous initiatives taken by the government dedicated to the promotion of housing, access to adequate and affordable housing particularly among the poor, remains a daunting challenge of our time. In part, this is due to the limited impact the National Building and Research Agency (NHBRA) research and innovation, operations and activities have had since its establishment in 1971. The aim of this assignment was to conduct a review of the NHBRA operations particularly with regard to the development and promotion of affordable housing products.

1.2 The Terms of Reference (ToR) and Scope of the Work

The objective of this assignment was to conduct a review on NHBRA operations in relations to the development and promotion of affordable housing products. The assignment required the Consultant to execute the following ToR.

1.2.1 Review available (alternative) materials and technologies used in construction of houses

The objective of this activity is to develop a good understanding of the economic/technical acceptability of the available building materials and technologies that have been developed by NHBRA and are being used in the construction of houses. This will lead to developed and tested knowledge of building materials and related technologies, and enable improvements in the use of locally available building materials and related construction technologies. The consultant shall also explore different low cost building low cost technologies that can be adopted in Tanzania. This will further stimulate the implementation of local production in order to improve the main elements of a house using different local materials and technologies. The assignment entails evaluating the level of knowledge and extent of adoption of the following:

(a) Cement stabilised soils for substitution of cement stabilised sand bricks/blocks;
(b) Sisal concrete roofing sheets for substitution of metallic sheets for roofing;
(c) Pozzolana and Pozzolime for partial or total substitution of Portland cement;
(d) Timber for improved use in structural elements;
(e) Tile vibrator for roofing tiles production;
(f) Tile moulds for roofing tiles production; and
(g) Press machines for interlocking bricks production.

1.2.2 Compile information on availability and affordability of different NHBRA materials and technologies used in different parts of the country

This will include collection of all available information on building products developed by NHBRA, their characteristics, prices, places of production (within Tanzania) and their production capacity, and affordability levels within the target population.

1.2.3 Review the impact and relevancy of research findings carried out so far in improving the housing conditions in the country

This activity will include assessment of the successes and/or failures in the implementation of past NHBRA research findings by the larger population of Tanzania, including wide publicity, scale of production and product updating.

1.2.4 Evaluate NHBRA's information documentation system, identify weaknesses if any, and propose the methods of overcoming them.

The Consultant should study the current information documentation system at NHBRA, document its shortcomings, and assess its adequacy in terms of techniques and personnel. The consultant shall propose methods to overcome the shortcomings identified in line with the current best practices in information documentation systems.

1.2.5 Evaluate NHBRA's products dissemination programmes, identify weaknesses if any, and propose methods of overcoming them.

The Consultant shall review the current dissemination methods at NHBRA, document its shortcomings, and assess its adequacy in terms of techniques and personnel. The consultant shall propose measures to overcome the shortcomings identified in line with the current best practices in products dissemination programmes.

1.2.6 Review and propose how NHBRA could facilitate the objectives of Housing Finance Project especially in the area of affordable housing.

The Consultant shall study, assess and establish how NHBRA could be properly aligned to the primary objectives of the Housing Finance Project. In undertaking this, the Consultant is expected to establish the existing collaboration between the NHBRA, other institutions and informal groups involved in the development of housing in the country and recommend actions to strengthen them.

In reviewing the NHBRA operations, the consultant shall consult with relevant stakeholders including, real estate developers, social security institutions, small scale building materials production units, building contractors, local government authorities, professional bodies, research and teaching institutions, small scale *'fundis'*, property owners associations, builders in new housing development areas, local media, nongovernmental organisations dealing with promotion of appropriate housing and other stakeholders related to low cost housing.

1.2.7 Additional issues incorporated after consultation with the client

Overall, the six ToR outlined above cover more or less the critical aspects that concern NHBRA operations particularly with regard to the development and promotion of affordable housing products. However, from our in-depth reflections on the ToR, it was necessary to add the following

(i) The perceptions of NHBRA technologies and building materials

In order to be a in position to explain the why technologies and building materials hitherto produced by NHBRA have had little impact on affordable housing, it was necessary that

qualitative assessment of the perceptions of and attitudes towards NHBRA technologies, building materials and housing products in general be also undertaken.

(ii) Review of experiences from other countries in the region

In order to be in a position to draw lessons from other countries, especially from the sub-Saharan Africa countries, it is important to review experiences from selected countries. The countries are Kenya, South Africa, Ghana/Nigeria and Zambia. Also because of the increasing challenges India is facing in the delivery of housing to particularly the urban poor, a snap shot depicting the situation in India is also provided. This review also aimed at examining the best practices and successful stories in the promotion and use of locally designed technologies and building materials to expedite access to affordable housing.

(iii) Link with the private sector

Owing to increasing and indispensable role the private sector (both, individuals, firms and companies), the link between NHBRA and the private sector are given special attention, however as a cross-cutting issue (across the TOR).

1.3 Methodology

1.3.1 The study process

This assignment is basically an evaluation work; and thus an ex-post study. The diversity of the Terms of Reference (ToR) and pertinent issues, on the review of the National Housing Building Research Agency (NHBRA) Operations on Development and Promotion of Affordable Housing Products, require data and information collection approaches that combine several methods and tools. It also calls for the deployment of data collection strategies that provide opportunities for an in-depth understanding of the specific operations and activities which NHBRA is engaged in as well as products innovated, developed and disseminated. Furthermore, the review methods have to capture and facilitate assessment of views and perceptions of various stakeholders (proponents and critics) of the materials and technologies developed and promoted by NHBRA.

1.3.2 Sources of data

In order to ensure systematic collection of the data a matrix which relates the ToR and the potential sources of data and information was prepared as indicated in Appendix 1. Besides, specific methods, tools applied to collect data and specific outputs are elaborated in Appendix 2.

In preparing the fieldwork instruments, special attention was paid to formulating questions which explored and provided responses to the questions *what and why concerns* of the technologies and building materials developed and promoted by NHBRA. The main steps involved in data collection were:

(i)Review of published/printed materials

Review of secondary data and information sources focused on published and printed documents such as reports, applicable policies, guidelines, working papers, including scholarly materials produced by NHBRA and individuals or institutions on matters that concern development and promotion of affordable building materials and technologies. Written relevant works available in the internet were also searched. This review was done with reference to all the ToRs. The review of secondary sources provided useful data and information including potential institutions and actors who have used or modified the materials and technologies innovated by NHBRA. The review was instrumental in the course of preparing a checklist interview-questionnaires. Concurrent with desk work reviews, preliminary consultations were held with NHBRA officials so as to get deeper insights into the various aspects of the ToR.

The emphasis during the literature review was on the collection of both qualitative and quantitative data. Appendix 2 further elaborates the methods, instruments and deliverables during both the review of literature and fieldwork studies.

(ii)Fieldwork studies

Using the data collection protocols, face to face interviews were conducted in selected up country areas (Appendix 3). The focus was on areas where NHBRA has disseminated their materials and technologies; built demonstration buildings and or trained local communities to use the materials and technologies they have innovated. Issues that concern extent of adoption and or improvisation done were also explored.

A stratified sampling of the project site areas where materials and technologies developed by NHBRA was undertaken based on the following criteria:

(i) Coverage of at least two sites where each of the building materials and low-cost technologies outlined in the ToR have been piloted, tested or used. The selection of the two sites focused on the areas where the materials and technologies advanced by NHBRA have been propagated or disseminated leading to extensive and successful use as well as those areas where they have been least success or utilization. In selecting the two sites, careful corroboration and reference was also made to the findings from the review of secondary sources (literature search), and initial views and information collected during the interviews with various officials.

(ii) Cases where the building materials and or technologies initially developed by NHBRA have been improvised or improved to enhance acceptance, durability, quality and or quantity or production capacity etc;

(iii) Sites or areas (if any) where the materials and technologies developed by NHBRA were adopted, but later abandoned over time; and

(iv) Situations where building materials and technologies were propagated (and piloted) but there has not been any initiative by private individuals or the public sector to adopt the materials or technologies.

The composition of stakeholders interviewed is outlined in the following subsections.

(iii) Interviews with NHBRA staff

In order to get a deeper understanding of the various issues outlined in the ToR, including information on aspects such as availability and affordability of various materials and technologies advanced by NHBRA, first the location of pilot and other projects implemented by NHBRA were identified. Thereafter, interviews aimed at providing insights into various aspects including location of pilot or demonstration projects, availability of building materials and technologies advanced by the organization and impacts of the research activities undertaken so far with regard to the improvement of housing conditions in the country were done. Interviews with NHBRA revealed the type of information and data management systems in place.

Furthermore, during the interviews with NHBRA staff, mechanisms, programmes and methods through which NHBRA disseminates its products including inherent weaknesses were documented. Interviews with NHBRA were also intended to explore the existing capacity, in terms of equipment, laboratories, office accommodation and human resources and so on.

(iv) Interviews with officials from selected institutions

Apart from NHBRA, interviews were also conducted with officials from few selected institutions which have been cooperating with NHBRA directly or indirectly. These included interviews with persons in training and research institutions such as the Ardhi University, the University of Dar es Salaam (COET); the Dar es Salaam Institute of Technology (DIT); the National Construction Council (NCC); the Tanzania Building Agency (TBA); the National Housing Corporation (NHC), the Vocational training Authority (VETA) and the Commission for Science and Technology (COSTECH). Interviews were also held with the relevant staff at the Ministry of Lands, Housing and Human Settlements Development (MLHHSD, selected LGAs, as well as with officials from relevant NGOs (i.e. WAT- HST & CCI), and CBOs, real estate developers, social security institutions (PPF, NSSF, LAPF etc.). In addition, local formal and informal producers of building materials and technologies advanced by NHBRA were interviewed. Critical issues of concern during the interviews with these stakeholders were:

- the concerns (negative and positive) about building materials and low-cost technologies advanced by NHBRA;
- the views on synergies which could be tapped to improve performance including quality, availability, affordability, marketing and use of the NHBRA materials and low-cost technologies;

- the role NHBRA and its partners could play in facilitating the realisation of the objectives of the Housing Finance Project (HFP), especially with regard to affordable housing development;
- the impacts (including shortcomings) of the research activities and findings undertaken so far, to improve housing conditions in Tanzania; and
- capacity, quality, accessibility, price and affordability concerns regarding the building materials and low-cost technologies advanced by NHBRA.

(v) Interviews with direct beneficiaries

The consultants conducted interviews with direct beneficiaries or users of the technologies and building materials developed by NHBRA. These were particularly critical because one of the main objectives of the various activities undertaken by NHBRA since its establishment forty years ago, includes to research on and improve access to low-cost building materials and technologies; necessary to improve housing conditions in the country. In order to improve reliability of the data collected, apart from interviews with individual users/beneficiaries, also focus group discussions (FGDs) were also held with groups of between 4 and 6 persons comprising both being users and non-users. Data from the various sources were triangulated to ensure validity of the findings.

1.4. Organisation of the report

This report comprises ten chapters. Chapter One provides the introduction which includes the objectives and Terms of Reference; study methodology and the structure of the report. Chapter two presents the institutional framework for affordable materials and technologies focusing on the relevant legislations, policies and structures in place and roles assigned to the specific institutions.

Chapter three focuses on the NHBRA institutional setting. Important aspects which relate to the performance such as statutory roles and functions of NHBRA organisation structure, resource capacity, strength, weaknesses, opportunities and challenges are also underscored. In addition, an analysis, of NHBRA using the PESTEL model is presented in the Appendix. Chapter Four discusses the experiences from selected countries, the thrust of discussion is on the non-conventional materials and technologies used in countries reviewed including the challenges the countries are facing with regard to the use of non-conventional materials and technologies. Chapter Five presents the types of alternative building materials and technologies which NHBRA had innovated, their acceptability and extent of adoption. Chapter Six discusses issues pertaining to availability and affordability of NHBRA materials and technologies. In Chapter Seven, impacts and relevancy of the research activities undertaken by NHBRA on affordable building materials and technologies are presented. Issues that concern laboratory testing are also obtained.

Chapter Eight discusses NHBRA Information documentation (management system), focusing on the various documentation forms and formats, the purpose they serve, information organization system and process. Existing documentation facilities including equipment their uses as well as their adequacy and inadequacies are uncovered. Best practices from other relevant institutions are also examined. Chapter Nine reviews the existing modes of dissemination of NHBRA products, the marketing, resource capacities required for dissemination, adequacy and inadequacies of the current dissemination system methods and tools. Chapter Ten presents the conclusions and recommendations.

Chapter Two

Institutional Framework for Affordable Materials and Technologies

2.1 Introduction

This chapter reviews the major institutional frameworks relevant to the utilization and use of affordable building materials and technology in Tanzania. It includes international conventions, national macro and micro policies, Acts of Parliament, regulations and strategies. Reviewed in this chapter also is the institutional framework for affordable materials and technologies in the country as well as the housing finance project. Key emerging issues are outlined at the end of this chapter.

2.2 Regulatory Framework

2.2.1 International Conventions

There are various international conventions and Agenda that promote technological innovation and use of cost effective building materials so as to achieve adequate housing. These include:

Objective 1 of the African Union (AU)/NEPAD on strategic objectives in the science and technology sector stipulates the need to: “enable Africa to harness and apply science, technology and related innovations to eradicate poverty and achieve sustainable development”.

Objective 5 of the AU/NEPAD strategic objectives on environment and climate change stipulates the need to: “promote integration of environmental issues into poverty reduction strategies“.

On the other hand S**ection 88 of the Habitat Agenda** “provides that: public policy and private investment should, together, facilitate an adequate supply of cost effective building materials, construction technology and bridging finance to avoid the bottlenecks and distortions that inhibit the development of local and national economies“. The Agenda further notes that by improving quality and reducing the cost of production, housing and other structures will last longer, be better protected against disasters, and be affordable to low income populations and accessible to persons with disabilities, which will provide a better living environment. To respond to this objective the government at all levels, including local government are required to:

i) Encourage and support the establishment and expansion of environmentally sound, small-scale, local building materials industries and the expansion of their production and commercialization;
ii) Provide policies and guidelines to facilitate fair market competition for building materials with enhanced participation of local interested parties and establish a public mechanism to enforce them;

iii) Promote information exchange and the flow of appropriate environmentally sound, affordable and accessible building technologies and facilitate the transfer of technology;
iv) Reformulate and adopt building standards and by-laws, where appropriate, to promote and permit the use of low-cost building materials in housing schemes, and use such materials in public construction works; and
v) Promote partnerships with the private sector and non-governmental organizations to create mechanisms for the commercial production and distribution of basic building materials for self-help construction programmes.

These are relevant provision to NHBRA mission to provide affordable building materials and technologies.

2.2.2 National macro policies and legislation

i) The National Development Vision 2025

The Vision 2025 has three major principle objectives that aim to be attained by 2025. These include achieving quality and good life for all; good governance and rules of law; and building strong and resilient economy that can effectively withstand global competition. These objectives aim at elevating Tanzania from the least developed country to a middle class income country by 2025, with a high level of human development.

There are five main attributes that the Vision 2025 focuses on; these include: high quality livelihood, peace, stability and unity, good governance, as well as an educated and a learning society and a competitive economy capable of producing sustainable growth and shared benefits. Despite the fact that, the objectives and targets are very broad to be realized in a single sector like the construction sector, yet there are elements that can be linked up to affordable building materials and technologies. For instance, the availability and access to affordable housing will not only enhance the quality of life, but also enhance many concerns related to peace, stability and unity in the country. It has been pointed out in the Vision 2025 that these can only be achieved if there is good governance and competitive economy in the country. This implies that the utilization of affordable building materials requires strong political, economic and social commitment to interpret and transform the Vision into workable programmes. To what extent has NHBRA contributed to the realization of implemented in practice this vision or similar policies and programmes are among the key issues of interest. Needless to point out that the gap between housing demand and supply is widening day after day, at the same time, the availability, access to and utilization of affordable building materials by low income earners is still a challenge that is yet to be resolved.

ii) The National Strategy for Growth and Reduction of Poverty (NSGRP I and II)

The major focus areas of the national strategy for growth and reduction of poverty are improving quality of livelihood, peace, stability and unity, good governance, quality of education and

international competitiveness. On improvement of quality of livelihoods and good governance, the strategy recognises that the urban poor live in congested and mostly in un-serviced areas, overcrowded residences while the rural poor live in sparse homesteads with inadequate basic services. The majority of housing in rural areas and in un-serviced settlements of urban areas is in poor conditions, and lack security of tenure.

It was also noted in the strategy that the access and propagation of simple construction technologies which could help the supply of affordable housing is important. Although the strategy is not explicitly on the promotion of affordable building materials, it however, reorganizes in the broader sense that, the improvement of quality of life means the people ought to live in a clean and protected environment, which implies the need to provide quality and affordable housing.

NSGRP has operational targets to achieve the quality of life by ensuring increased access, affordable and safe water, sanitation and decent shelter and safe and sustainable environment, thus reducing vulnerability from environmental risks. Regarding, on this operational target, it is obvious that, the issue of availability of affordable building materials and technologies for construction of decent shelter is critical. This supports the main objective of establishing NHBRA.

2.2.3 National micro policies and legislation

There are numerous policies and Acts of Parliament that support the use of affordable building materials. Only the key ones are reviewed in this section.

i) The National Human Settlements Development Policy, 2000

The National Human Settlements Development Policy aims to facilitate adequate delivery of shelter and the development of sustainable human settlements in the country. Four, among the major objectives of the policy that concerns NHBRA activities, includes (i)to promote the use of and production of building materials that are affordable; (ii) to ensure planning legislation, building regulations, standards and other controls are consistent with the capabilities, needs and aspirations of the various sections of the population; (iii) to assist the poor acquire decent shelter; (iv) to promote capacity building of all actors involved in shelter delivery and human settlements development.

Section 2.3.8 of the policy underscores the role of NHBRA noting that in 1971 the Government established the Building Research Unit (BRU) with the assignment of researching into building construction and building materials with emphasis on rural areas. In addition to conducting research in different building materials, BRU was required to organise seminars, exhibitions, etc., as a means of disseminating researched findings in particular to rural construction units, supervisors for self-help housing, village governments, rural artisans and the public as a whole. However , although BRU had done a lot of research by then, it had been unable to disseminate its

research findings (URT 2000). Whilst, BRU (now NHBRA) embarked on housing improvement campaigns *(Nyumba Bora)* covering 30 districts in the country and managed to build demonstration houses in urban and rural areas, in recent years the operation of NHBRA has been demand-driven, limiting the attention of rural areas.

Section 4.1.2.1of the policy, further notes that existing building regulations are inflexible and unaffordable; and hence do not encourage people to build, but act as a hindrance to potential developers. Moreover, they do not give enough room for use of new innovations and technology. In that view, the policy states that building and construction standards shall be revised so that they can be functional and performance based rather than prescriptive. They should be flexible and affordable.

Section 4.2.4 states that raw materials such as sand cement blocks, burnt bricks, timber, roofing tiles, and corrugated iron sheets, aggregates, nails, cement, sand etc., are very essential elements in the construction of damp proof and durable housing. They should therefore be available in large quantities and at an affordable price to encourage housing construction. The production of building materials can be promoted by encouraging the establishment of building materials industries.

It is also reported in the policy that building material industries have not contributed sufficiently in employment creation and income generation. Most importantly, it is asserted that dissemination of application of building materials researched by BRU had not been very successful.

The policy states that (i) research shall be carried out on building materials that are currently being used with a view to making them more durable and affordable; (ii) Private and popular or informal sectors shall be encouraged to engage in the production of building materials by giving them incentives; iii) training on the production and use of local building materials at the local level, shall be carried out in Community Development Training Institution; (iv) Demonstration projects shall be carried out on housing development as a means of spreading the use of researched materials; (v) small scale industries for building materials at the community level shall be promoted; (vi) the use of local building materials in public housing schemes shall be encouraged; (vii) the use of building materials that cause environmental hazards shall be prohibited; (viii) the government shall encourage private investment in building materials production; (ix) the government, in collaboration with producers, shall review the price of building materials to encourage the use of durable building materials; and (x) in order for the building industry to play a significant role in the economy, the choice of technology in the construction of housing shall be made on the basis of the use of locally manufactured or processed building materials especially where their production process is high in labour content; building processes that encourage adoption of appropriate technologies and combine the use of semi-skilled and unskilled labour; the production and use of the locally made building material

are highly encouraged to enhance the adoption of new technology and combines the use of skilled and unskilled labour.

On the issue of rural housing the policy stipulates that the government shall facilitate implementation of the rural integrated programmes that will:

a) Enhance rural economies that are aimed at assisting rural families to construct and improve their houses,
b) Create employment and income through the production of building materials and provision of basic services; and
c) Conduct education and campaigns to educate the rural population on the value and benefits of good housing.

Section 4.2.4.2 (xi) of the policy states that the role and structure of BRU should be reviewed in order to facilitate dissemination and application of its research results. It is therefore proposed in (**Section 4.4.2 (iv))** that the institutional arrangement should be streamlined in order to facilitate successful implementation of the policy.

Section 4.4.2 (iv)(7) further notes that the Building Research Unit will be a Government Executive Agency in the human settlements development sector, which would assist it in improving housing conditions in both urban and rural areas; in particular, the agency was expected to offer the following:

(a) Conduct research and offer technical solutions to housing problems of the low-income groups;
(b) Carry out applied research aimed at finding practical solutions to intermediate housing problems facing the people;
(c) Offer consultancy services to the public on building and construction; and
(d) Collaborate with the Institute of Human Settlements Studies (then Institute of Housing Studies and Building Research) of the former Ardhi Institute and other institutions on common areas of research.

ii) The National Construction Industry Policy, 2004

Since the 1990s there has been a marked increase of uncoordinated initiatives geared towards fostering the construction industry. The construction sector needed a comprehensive policy to ensure compliance with the national, social and economic development objectives and goals. The Policy aim at attaining the requirement of the National Development Vision 2025

Among the main objectives of the National Construction Policy that are relevant to NHBRA activities and operations in attaining materials and technologies are to support socio-economic development activities such as road works, water supply, sanitation, shelter delivery and income generating activities; to ensure application of practices, technologies and products which are not harmful to both the environment and human health.

More specifically, **Section 8.1.9(c)** of the policy provides that the government shall promote the optimum use of low-cost and local building materials, innovative technologies and practices. It further stipulates that the government shall facilitate self-help initiatives and informal sector activities for adequate shelter delivery particularly through provision of building designs and construction practice guidelines. This will help the low-income earners and people with special needs including the aged and those with disability to have at least a house of minimum required standards.

iii) **The National Science and Technology Policy, 1996**

Among the general objectives stated in Section 16 of the policy includes promoting new and emerging technologies with a view to acquiring capability and capacity to embark on the technologies.

Section 31 of the policy describes the objective of the building and construction industry and among other strategies it stipulates thus, ”in building and construction industry, efforts shall be directed to strengthening institutions dealing with building in order to develop and promote the use of locally available, adapted designs, and alternative building and construction materials for construction.”

iv) **The Urban Planning Act No 16 of 2007**

Section 7-(4) and 5(q) of the Act provides that, the Minister for urban development may, by order published in the Gazette and after consultation with the Minister responsible for Local Governments, designate anybody or organ established by an written law to be a planning authority or joint planning authority for the purposes of this Act. A planning authority shall in that capacity encourage the private sector to effectively contribute towards housing provision.

The Second schedule sub-section 2(b) provides the content of redevelopment schemes which includes the housing demand analysis that should comprise strategies for –

(i) Encouraging individual home ownership: and

(ii) Empowering the private sector to effectively contribute towards housing provision.

Section 27 of the Act provides for matters that have to be considered in all planning schemes as have been mentioned in the third schedule of the Act. Part B (1) (c) of the third schedule provides for the reservation of areas, zones and sites in the planning schemes for industries of various classes, warehousing and service trades, or any particular industry or trade including informal sector development: small scale industries for the production of low cost building materials.

v) The Local Government (Urban Authorities (Development Control) Regulations, 2008 (GN. No. 242)

These regulations are made under Sections56 and 57 of The Local Government (Urban Authorities) Act (Cap 288) as Revised in year 2000. Part VIII sections (a) to (k) of the regulations provide provisions on buildings. In particular, regulations 161 to 191 provide provisions for foundations, floors, wall and roofs.

According to regulation 168.-(I), the foundations of all walls, pillars or posts shall be of concrete, dressed stone or good sound burnt bricks laid in cement mortar or other suitable or substantial material, and shall be laid at such depth as to secure a solid bed for building on, and in the case of wall.

Regulation 170 describes the building suitable for floor construction. Floors may be made of concrete, stone, good sound burnt brick, hydrant brick, wood or other material approved by the Authority, provided that, in the case of wooden floors on the ground floor of a building, the Authority may require the concreting of the ground underneath and the rat-proofing or mosquito-proofing of any space between the floors and the ground and provided further that the Authority may, whenever it thinks fit, require a floor to be of concrete.

Regulation 171 provides the provisions for the materials not permissible for wall construction. The regulation says “No external wall shall, except with the written permission of the Authority, consist of any temporary erection of wood, cloth, canvas, grass, leaves, mats or any other inflammable materials, and no veranda or balcony shall be closed in with any material except wire gauze or glass without such permission, provided always that where a building abuts on a main road its walls shall not be constructed of corrugated iron.

Regulation 174 (1) states that walls may be built of concrete, concrete blocks, stone, good sound burnt brick or other similar material, or of galvanised corrugated iron or other material approved by the Authority; while regulation 175 (1) states that every wall built of concrete, concrete blocks, stone, good sound burnt brick or other similar material shall be properly bonded and solidly put together with mortar, and all return walls and partition walls shall be properly bonded to the wall adjoining them. Sub-regulation (2) states that, notwithstanding the provisions of sub-regulation (1) the authority may from time to time prescribe the manner of bonding of building materials depending on the change in technology. Further, regulation 188 (1) states that every roof shall be constructed of wood, iron, tiles or other impervious material.

It is clear from these government provisions that regulations do exist that guide NHBRA on the use of different building materials for housing construction. Despite the fact that many policies provide and promote the production and utilization of affordable building materials, the regulations give the emphasis on the safety, aesthetics and durability.

It has to be noted, however, that specific and separate Act on building and housing do not exist in Tanzania. The extent of use of affordable building materials is discussed in the ensuing chapters.

2.3 Institutional Framework for Affordable Housing

The role and mandate of NHBRA with respect to research on building materials and technology and dissemination/promotion of the same for particularly affordable housing is based on an explicit or implicit assumption that NHBRA has to collaborate with diverse community of stakeholders. These include several institutions that the issue of building materials and technologies; or have roles that complement and support the functions assigned to NHBRA. Some of the institutions are customers and others are suppliers. Customers include: the central and local governments departments; government agencies and parastatal organisations such as the National Housing Corporation (NHC) and the Vocational Education and Training Authority (VETA); research and training institutions; civil society organisations. The later include NGOs such as Centre for Community Initiatives (CCI), professional associations and religious organisations; international agencies that include UN-Habitat, UNDP, NORAD and the private individuals.

NHBRA does not seem to have fully transformed commensurate with the changed socio-political and economic trends in the country. Although, in recent years, NHBRA has cooperated with many institutions, the collaboration with the private sector which is the main promoter or supplier of housing in the country, is overall weak.

• 2.3.1 Central and local governments departments

NHBRA is collaborating with government ministries and departments in issues related to building materials and technologies. The agency is currently collaborating with the following public institutions:

- Ministry of Education and Vocational Training (MoEVT);
- Ministry of Health and Social Welfare (MoHSW);
- Ministry of Justice and Constitutional Affairs (MJCA);
- Ministry of Lands, Housing and Human Settlements Development (MLHHSD);
- Ministry of Home Affairs - Prisons Department;
- TPDF including JKT and
- Prime Minister's – Regional Administration and Local Government (PM-RALG).

Whilst NHBRA has to intensify linkages with the private sector, seeking more government political commitment and support is equally important. Unless the central and local governments show their commitment to support the use and promote the NHBRA materials and technologies; the growing challenges including those associated with the liberalised importation of building materials that NHBRA is facing and most importantly, the housing quagmire, are likely to worsen.

2.3.2 Government agencies and parastatal organisations

Several agencies and parastatal organizations collaborate with NHBRA in various aspects. The key institutions and their roles are listed in Table 2.1.

Table 2.1: Key government agencies and parastatal organisations

S/N	Institutions	Function or Role or Input
1.	National Housing Corporation (NHC)	Has shared information and acquired NHBRA technology
2.	National Construction Council (NCC)	Provided advise
3.	National Environmental Management Council (NEMC)	Shared environmental issues
4.	Small Scale Industries Development Organisation (SIDO)	Share technologies
5.	National Land Use Planning Commission (NLUPC)	Exchange information and guidelines on land use
6.	Professional Boards: Engineers Registration Board (ERB), Contractors Registration Board (CRB), Architects and Quantity Surveyors Registration Board (AQRB)	Shared professional knowledge
7.	Transport Authorities: Tanzania Railways Authority (TRA), Tanzania Zambia Railways Authorities (TAZARA)	Provide transportation services for building materials
8.	Tanzania Bureau of Standards (TBS),	Testing of building materials
9	National Development Corporation (NDC)	Information and technical support
10.	Tanzania Electrical Supply Company Limited (TANESCO)	Provide electricity
11.	Commission of Science and Technology (COSTECH)	Advice and access research funds

Source: Fieldwork study, April 2014

2.3.3 Training and Research Institutions

The institutions in this category that works with the NHBRA include: schools, colleges, universities and vocational education training authorities. They share information and technology and offer staff training. Some of the key institutions include: Ardhi University (ARU), the University of Dar es Salaam (UDSM) especially the College of Engineering and Technology (CoET), Dar es Salaam Institute of Technology (DIT) the Vocational Education Training Authority (VETA) and the Tanzania Industrial Research Development Organisation (TIRDO). .NHBRA also provides industrial training (IT) opportunities for students from ARU, St Joseph University, DIT UDSM, etc

2.3.4 Civic Society Organisations

NHBRA has also been collaborating with Norn-Government Organisations such as CCI, the WAT-Human Settlements Trust (WAT-HST), the Habitat for Humanity Tanzania, the Research and Poverty Alleviation (REPOA), the Association of Local Authorities (ALAT), the Institution of Engineers Tanzania (IET), the Association of Consulting Engineers Tanzania (ACET), etc. NHBRA has shared information and technology on its products as well as accessed knowledge

from these institutions. Table 2.2 displays an example of institutional arrangement for affordable housing scheme in Miyuji Dodoma.

Table 2.2: CCI - NGO collaboration for Affordable Housing delivery in Miyuji, Dodoma

Actor	Function/Role	Remark(s)
National Housing Building Research Agency (NHBRA)	• Offered technology • Trained CCI technical officials	Has no office branch in Dodoma
Centre for Community Initiatives (CCI)	• Disseminated NHBRA technology • Trained members of the Federation • Offered loans through fund obtained from Shack Dwellers International	• Seed money has been used to establish revolving fund operated by the Sejeseje an Muungano Housing Cooperative Societies; • CCI has technical support staff in Dodoma
Federation of the Urban Poor (FSC)	• Mobilised and provided loans to members, • Facilitated households to secure micro-loan from the CCI	Have more than 2,000 members in Dodoma
Households (HH)	• Applied for loan and repaid in four years, • Manufactured interlocking bricks, • Built the houses	• Low income households • Have no capacity to purchase own machine

Source: Fieldwork, April 2014

2.3.5 Local community members and the public

NHBRA undertakes community awareness and training to household members in villages and in urban centres by conducting exhibitions and training of community members on how to make and use bricks and tiles. Demonstration structures, including houses and office buildings, have also been erected in urban and rural centres for public awareness creation.

2.3.6 Development Partners (Donors)

NHBRA collaborates with several international organisations in various aspects including technical and financial support. They include: the United Nations Development Programme (UNDP), the United Nations Human Settlements Programme (UN-Habitat), United Nations Industrial Development Organisation (UNIDO), the United Nations Environmental Programme (UNEP), and the International Labour Organisation (ILO), etc.

2.4 The Housing Finance Project

The formal housing construction sector in Tanzania is small and is largely being undertaken by the public sector either through NHC, the TBA or through social security funds and some by private individuals. The private or"organized" developer/builder market is equally small. The private housing promoted by NHC and TBA led to luxury units aimed at up market social groups. Among the reasons given by real estate developers for the lack of organized multifamily residential development in Tanzania is high cost of construction using imported building materials.

The Housing Finance Project (HFP) addresses the area of deepening reforms in the financial sector and an enabling environment for private sector activities under the growth of the economy and reduction of income poverty. Component III of the HFP project provides for the housing the: "expansion of affordable housing supply". A range of measures are listed that have to be undertaken, including promoting the use of low-cost construction technologies as a way to make housing more affordable. One of the activities under this component include promoting the use of low-cost construction materials, technologies and design that make formally built housing more affordable.

The objective, therefore, is to introduce and to promote building material technologies and design that are not only low-cost but can also be mass-produced to meet the construction demands of the sector. Some of such building technologies have already been tried and tested by the NHBRA, and several other players in the sector are also exploring and introducing new low-cost technologies for building construction. However, their market penetration has been limited so far due to the lack of production capacity and the lack of awareness on the NHBRA building materials and technologies in the market. The HFP could therefore fill in the gap by providing support to NHBRA and other critical capacity building requirements building materials and technologies, including dissemination.

2.5 Emerging Issues

Four major issues that emanate from the review of the institutional framework for affordable building materials and technology are:

1. There are supportive international conventions as well as various national policies that promote and support core activities of NHBRA;
2. The role and mandate of NHBRA with respect to research on building materials and technology and dissemination/promotion of the same for particularly affordable housing is based on an explicit or implicit assumption that NHBRA has to collaborate with diverse community of stakeholders. Generally, NHBRA has collaborated with many public institutions. However, there seems to be weak collaboration and engagement with the private sector actors. The private sector is the main promoter or supplier of housing in the country;

3. Whilst NHBRA has to intensify linkages with the private sector; the importance of government/political commitment and support cannot be underestimated.
4. NHBRA can be the key player in the implementation of the National Housing Finance Project but needs capacity building. However, at present it has no capacity to meet the HFP provision.

Chapter Three

NHBRA Institutional Review

3.1 Introduction

This chapter provides a description of the historical development of NHBRA and its institutional transformation since the 1970s. The vision and mission of the institution, resource capacity and SWOC analysis are also described in the chapter, while it ends with emerging issues.

3.2 Historical Development of NHBRA

Since independence there have been a number of government-led initiatives geared towards fostering the local construction industry. Among them are: establishment of the Building Research Unit (BRU) in 1971 and the Tanzania Bureau of Standards (TBS) to support production and utilization of local building materials, standards and specifications; establishment of the National Construction Council in 1981 to promote the development of the construction industry; formulation of the Construction Industry Development Strategy in 1991 to guide the development of an efficient and effective construction industry; establishment of vocational training centres, expansion and improvement of training institutes and universities so as to address shortage of skilled manpower in the construction industry; and the establishment of regulatory institutions in the Construction Industry such as the Contractors Registration Board, Architects and Quantity Surveyors Registration Board, Town Planners Registration Board, and Engineers Registration Board. The regulatory bodies were established to register, regulate activities and develop contractors, consultants and professionals in the construction Industry.

The National Housing and Building Research Agency (NHBRA) formerly, National Housing and Building Research Unit (BRU), has been researching and developing building materials and affordable technology over the last four decades. With financial support from the Kingdom of Norway through NORAD, BRU was established as a research unit under the Ministry for Lands, Housing and Human Settlements Development. The Norwegian Building Research Institute provided professional support services to the BRU throughout the early years up to 1985. The initial mandate of BRU was to provide technical support for housing construction in the country through enhanced use of local building materials. This institution came about at the time the government was devising measures to curb the growing housing problem in the country. Some of the housing measures that were carried out concurrently with the setting up of the BRU included the National Sites and Service Schemes, which had replaced the Squatter Demolition Scheme of the earlier years. The launching of the Tanzania Housing Bank (THB) followed in 1973 and its subsidiary company, the THB Estates Company followed thereafter. BRU and THB Estates Company collaborated in setting up schemes for demonstration purposes. In the early years of the BRU, there were concerted efforts towards working with the other housing agencies in the country. For instance, the National Housing Corporation that had been set up in 1962 had two subsidiary companies that made use of the research finding from the BRU. These were the Kisarawe Brick Factory Company and the Tanzania Concrete Articles Company (TACONA).

The governments' expectations from the BRU were not only limited to researching on building materials and technology, but also included broader mandate of developing technical capacities in four key areas; namely:

(i) BRU as a science and technology incubator for developing materials and technology that would be used in the construction industry to promote the use of durable and affordable materials. This function persistently featured as the key area of focus of the BRU, now the NHBRA;
(ii) BRU as a technical service organisation that researches on architectural and construction cost with the aim to improving on house design layout, specifications and cost of housing building;.
(iii) BRU as a repository of housing building data that will inform decisions in the housing industry; and
(iv) BRU as a technical advisory service organisation in the areas of compliance to house building regulation, standards and related development controls.

BRU was set up to provide technical support related to housing construction by increasing the use of locally available building materials with emphasis on;

- Durability of the houses;
- Affordability;
- Capacity building;
- Research on building materials and technologies at applied level;
- Design of improved house layouts;
- Provision of data sheets on building materials and methods of construction, and
- Analysis of the financial aspects of building construction.

As a result of these broad mandates, the BRU carried out a number of activities in the country during its early years of operation which covered the following areas:

(i) Set-up materials laboratory at its headquarters in Mwenge Dar es Salaam city, to develop alternative building materials using locally available raw materials and appropriate building technologies both for production of buildings and production of materials;
(ii) Conduct convenient Housing condition survey throughout the country to determine levels of compliance with set standards and general regulations; and
(iii) Develop national building regulations that were expected to form the basis of all approvals of house construction. The first draft was made in 1975, and subsequent versions in 2001 when the task of developing the regulations was transferred to another government agency.

Generally, BRU lived to the expectations of the government and recorded to the wider public, successes in many of the activities it executed. With growing economic difficulties and low capacity in attracting technical cadres especially in the areas of civil engineering, architecture

and quantity surveying graduands, BRU lost some of its core functions to other agencies altogether. In 2001, the BRU was transformed into a Government Agency. The Agency was entrusted with more or less the same mandate.

3.2.1 Institutional Transformation of NHBRA

Establishment of the National Housing and Building Research Unit (BRU)

Since its establishment in 1971, BRU now NHBRA, has operated under five distinct central government institutions indicated below:

- Ministry of Lands, Housing and Urban Development (1971 - 1984)
- Prime Minister's Office- PMO (1984 - 1985)
- Ministry of Water, Lands and Urban Development (1985 - 1987)
- Ministry of Local Government, Marketing and Cooperative (1987 - 1990)
- Ministry of Lands, Housing and Urban Development now Ministry of Lands and Human Settlements Development (1990 - 2002)

Transformation of BRU to NHBRA

Following the implementation of the Civil Service Reform Programme (CSRP) which started in 1998, in August 2001 BRU was transformed into a government executive agency, under the name National Housing and Building Research Agency (NHBRA). As a semi-autonomous institution established under the Executive Agencies Act, 1997(Act No.30 of 1997) and subsequent Regulations 1999, it remained under the Ministry of Lands, Housing and Human Settlements Development.

There were two main reasons for the transformation; these are:

i. To reduce the burden to the government
   - By transforming the organisation, into a semi-autonomous government agency, it was expected to reduce burden to the government by generating revenue through doing research on building issues and offering consultancy services in design and supervision of buildings to the public at cost. The focus of the institution was on low cost construction of buildings and infrastructure services
   - Through creation of own management structure, and getting away from being a Department in the Ministry.

ii. To ensure efficiency of the organization
   - Through transformation and specification of the functions of NHBRA, to help in increasing the performance of the organization.

3.3 The Vision, Mission and functions of NHBRA

The Vision

NHBRA's vision is to be the Centre of excellence in research for affordable and adequate housing and appropriate technology on habitat issues in Tanzania by the year 2025.

The Mission

NHBRA's mission is to provide Tanzanians affordable high quality services and products of appropriate housing materials and technologies that reduce construction costs through innovative solutions to satisfy customer needs for improved shelter and hence quality of life.

In pursuit of its mission, the agency is guided by five values namely: productivity, innovation and entrepreneurship; quality and best practice; customer care; professional and ethical standards; and responsibility to society.

Functions of NHBRA

In order to achieve the above, NHBRA operates in seven areas:

i. Conduct research on building materials and building technology at applied level;
ii. Collaborate with the central and the local government authorities, NGOs, CBOs, development partners and individuals, in the formulation and training of grass-root building construction and production teams/brigades;
iii. Promote capacity building (i.e. technical, financial, and managerial) of all actors involved in shelter delivery and human settlements development;
iv. Ensure that planning, legislation, building regulation, standards and other controls are consistent with capabilities, needs and aspirations of various sectors of the population;
v. Promote the production and use of local and affordable building materials;
vi. Demonstrate the use of local building materials; and
vii. Advise the government and the public on matters pertaining to housing and human settlements issues.

Strategic objectives

According to the NHBRA Strategic Plan, the strategic objectives of the Agency are:

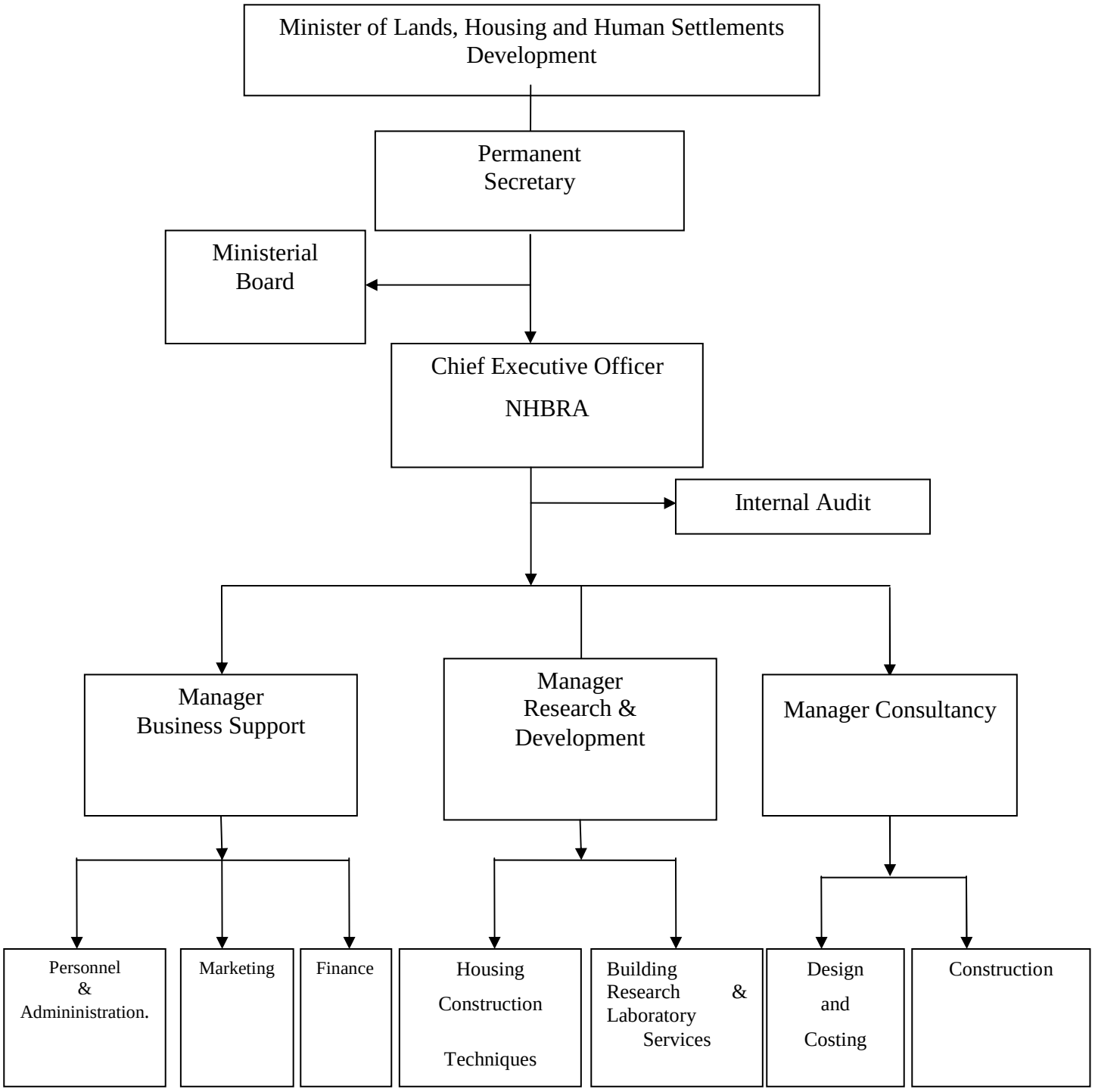
i. To ensure that research information on building materials, housing and human settlements development issues is made available to meet customers' needs in the required time scale;
ii. To increase promotion efforts so that for every 100 houses built within five years in each geographical zone, 10 are constructed using affordable and durable local building materials (LBM) and appropriate technology recommended by the Agency;
iii. To provide high quality building research and consultancy in construction services;
iv. To satisfy NHBRA's customers by providing products and services in the required time, quality and quantity; and
v. To improve financial management and sustainability.

3.4 NHBRA Organizational Structure

In the earlier stages of its operation, BRU was a department within the Ministry of Lands, Housing and Urban Development. After being transformed into an Agency, it became semi-

autonomous with specific departments or units. Figure 3.1 presents the organogram of the NHBRA.

Figure 3.1: NHBRA's Organizational Structure



Source: NHBRA Performance Appraisal Report of 2007/2008

NHBRA is under the Ministry of Lands, Housing and Human Settlements Development and guided by the Ministerial Advisory Board.
At present NIIBRA has three departments which are headed by the managers and structured as follows:

i) Department of research and development laboratories;
ii) Department of Business Support; and
iii) Department of consultancy.

It is clear from the organisation structure (Figure 3), it lacks an important department that ought to deal with information and dissemination of NHBRA products. According to the interviews these functions are being handled by the business Support Department, and this is considered as non optimal arrangement. In addition, there is a need to restructure the existing organisation structure so as to harmonise the existing units and do away with apparent overlaps between housing construction techniques, design and costing and construction.

It is also noteworthy that the institution is highly centralised and does not have branches in the up country regions or zones.

3.5 NHBRA Resource Capacity

Personnel

In terms of personnel, NHBRA has staff members in all disciplines that are relevant to research and dissemination activities in building materials and technologies. At present, the agency has a total of 51 staff members, which include: 1 mechanical engineer, 7 civil engineers, 2 architects, 1 sociologist,2 economists, one marketing and one information officer. However, despite being a research institution, NHBRA has only one PhD holder, nine Masters degree holders. There rest are technical staff and supporting staff. Considering the number of staff with MSc degree on post, it would appear that their capacity has not been effectively utilized to fulfil the core function of the institution. For this reason there has not been much in terms of publications in recent years. This suggests research culture has deteriorated and would thus require extra efforts to revamp it. On the other hand the shift and preference for consultancies rather than research among the staff, poses practical challenges particularly with regard to workload distribution between the two core functions.

Buildings Support Facilities and Equipment

NHBRA has the following facilities:

i. Staff Offices and library 180 m^2
ii. Laboratory with various machines such as soil test (machines which are modern), concrete tests, Cinva-Ram block making machines and vibrating table. for carrying out tests of materials and produced products.

iii. Warehouse 80 m^2
iv. Cafeteria 25m^2
v. Open yard 600 m^2

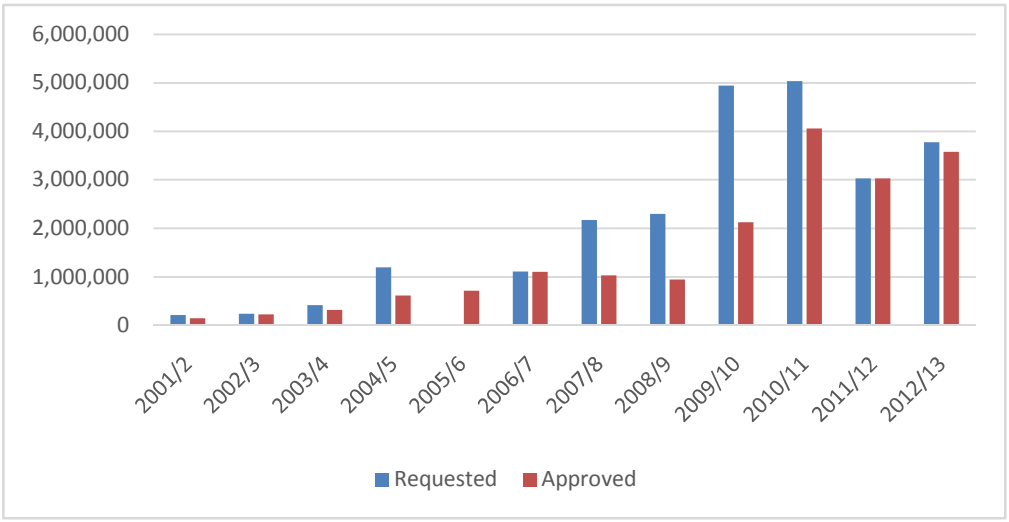
Generally, the available laboratory equipment are old and out of date. Others have broken down and are thus grounded. The current infrastructure and equipment that NHBRA has, therefore, are not adequate to effectively execute its mandate. According to the interviews with NBHRA official some of the facilities and equipment which are lacking are steel and timber testing machines, modern equipments for road construction materials and road compactness testing. Outdated machine include concrete strength testing machine.

Financial Resources

Although NHBRA is a government Agency which is supposed to financially be self reliant, it has and continue to depend on the government subvention at 83 percent of its operations costs. Indeed, all salaries of its staff come from the government budget allocations.

Figure 3 shows the trends in government subvention to NHBRA. The Figure shows that over the ten year period NHBRA had been receiving funds less that its requirements. In the 10 year period, NHBRA had been receiving between 53 and 83 percent of the requested funds. This had affected the capacity of the Agency to deliver building materials and technologies to a large part of the country.

Figure 3.2: The Government Subvention to NHBRA 2001/2-2012/13 period (Figures in TShs)



Source: NHBRA, April, 2014

Apart from annual budgetary allocations, NHBRA carries various research activities and consultancy services that earn it finance and other products:

i. Offering consultancy in design, costing and supervision particularly of low cost, hence construction and advisory services on matters that relate to building materials and technologies and affordable shelter;
ii. Training courses and seminars on affordable housing;
iii. Contracted socio-economic surveys and research on housing and human settlements issues;
iv. Testing of building materials and structures,;
v. Carrying out site investigations such as soil analysis;
vi. Building contracting and providing carpentry services;
vii. Renting out office space, equipment and instruments; and

3.6 SWOC Analysis

In order to get deeper insights into the capacity and constraints of NHBRA to discharge its functions, this section presents an evaluation of NHBRA using the SWOC analysis. SWOC analysis was preferred to PESTEL model, because data and information on the specific issues were not available (Appendix 4). The Strengths, Weaknesses, Opportunities and Challenges facing the Agency were examined as presented below.

Strengths

i. NHBRA is a legal entity and well-established government institution that came into being by the Act of the Parliament 30 of 1997 (NHBRA, Act of 2009)
ii. NHBRA has a total of 51staff on post (24 professionals and technicians) permanent staff with relevant skills in the field of housing and building research and technologies
iii. NHBRA has staff members with rich experiences in conducting training in affordable building materials and technologies,
iv. NHBRA has developed a number of products- technologies and building materials that are acceptable and used in different parts of the country;
v. Technologies and building materials that have been developed by NHBRA (e.g. sand cement interlocking blocks) have been adopted in large housing projects;
vi. NHBRA has a strategic plan, with vision and strategic objectives as well as a business plan;
vii. NHBRA has operational policies and procedures;
viii. NHBRA has basic research and working tools, and facilities including offices and a laboratory.

Weaknesses

i. Inadequate staff members with requisite research skills needed in research;
ii. Low commitment of some staff members;
iii. Low capacity for product promotion and dissemination;
iv. Lack of impact or outcome assessment of the use of NHBRA products;

v. Poor marketing strategies for NHBRA products
vi. NHBRA has a small piece of land with little room for expansion.
vii. Quality management system has not been operationalised;
viii. Lack of succession plan (aged staff members);
ix. Low staff retention capacity;
x. Over-reliance on government subvention for research and other operational activities;
xi. Over centralisation of NHBRA activities in Dar es Salaam;
xii. Insufficient (weak) links with the communities, private sector, LGAs and academic institutions;
xiii. Failure to tap into the unfolding opportunities of high demand for building materials and technologies in the country;
xiv. Low research and innovation capacity;
xv. Weak institutional and inertia to reform;
xvi. Un-operationalised customers satisfaction system
xvii. Little dynamism in resource mobilization; and

Opportunities

i. Existence of supportive national policy environment (macro and micro policies);
ii. Growing needs for NHBRA affordable building material and technologies;
iii. High potential collaboration with R&D institutions and technical institutions (e.g. universities, COSTECH, VETA);
iv. Increasing potential of large scale users of NHBRA materials and technologies (TBA, NHC, Pensions Funds, Watumishi housing scheme);
v. Existence of potential partners focusing on low income housing NGOs (e.g. Gold, CCI , WAT-HST);
vi. Increasing popularity of alternative non-conventional materials and technologies

Challenges

i. Misconception about NHBRA materials and technologies (quality concerns);
ii. Increasing competition from especially attractive and cheap sources of conventional building materials and technologies;
iii. Non availability of NHBRA materials and technologies in the market
iv. Undeveloped market outlets;
v. Lukewarm attitudes on NHBRA products;
vi. Absence of requisite regulations, standards and certifications for NHBRA products;
vii. Inadequate financial resources for Research and Development (R&D);
viii. Preference for consultancy over R&D among most NHBRA staff; and
ix. Low affordability among most low-income household.

3.6 Emerging Issues

Specific issues that have emerged from the NHBRA institutional review include:

1. NHBRA is an old research institution in Tanzania that has specialised on building materials and technologies. It has grown from a department of the Ministry of Lands, Housing and Human Settlements Development to a semi-autonomous agency of the government. The transformation has implied more functions and expectations;
2. Apart from the view that the research capacity of the existing professional staff is low, technical staff members on posts are inadequate and generally the staff have unfavourable age profile, several will retire within the next five years;
3. The weaknesses and challenges of NHBRA outweigh the strengths and opportunities. Although, NHBRA has the ability and experience in development of material and technologies that use local available material. It is currently handicapped to deliver to the requirement of its establishment, let alone the objectives of HFP;
4. The increasing role and mandate for NHBRA in the human settlements development, sector in the vibrant construction industry in Tanzania, requires a more robust institutional capacity and reforms; and
5. More political and financial resources support are necessary if NHBRA is to be transformed into the reputable research institution in the building materials and technology, that can play significant role in facilitating the implementation of the Housing Finance Project.
6. Considering the limited resources available for the organisation for research, the focus on consultancy, seems to fill in the void created by the failure to conduct research

Chapter Four

Review of Experiences from Selected Countries

4.1 Introduction

Non-availability of affordable housing especially for low income households is a problem most developing countries are far from resolving. In the quest to improve accessibility to affordable housing; enhance the quality of life particularly among the poor; and address the growing housing deficit for low income households, various countries in the developing world, sub-Sahara Africa being no exception, have initiated and implemented various programmes and projects, carried out research as well as reviewed building codes. Most activities among the programmes/projects and research engagements undertaken to improve housing for the poor have paid attention to the need to explore and use non-conventional building materials and technologies. The search for and promotion of affordable non-conventional building materials and technologies stem from, among other things, the inappropriateness and increasing costs of conventional building materials and technologies such as cement-sand blocks, steel, aluminium, corrugated iron sheets, paint products etc. The activities including research implemented to promote non-conventional building materials and technologies in selected countries (Kenya, Zambia, Zimbabwe, Sudan and India) in the next section:

4.2 Use of Non-conventional Materials and Technologies in Kenya

In Kenya, **s**helter is a basic need which is recognized in the bill of rights in the national Constitution. The Ministry of Lands, Housing and Urban Development, the National Housing Corporation (NHC) and research units of universities and other stakeholders in the housing sector are responsible for delivering affordable housing to Kenyans. The Ministries' target is to deliver 300,000 housing units per year so as to address the existing housing backlog and meet the annual housing needs which are estimated to be about 150,000 units per annum.

At present, most home-builders use conventional building technologies and materials such as cement and iron sheets. However, the rising prices of these materials and other housing elements amidst low incomes among the majority of urban residents have made these materials inaccessible to the bulk of low and middle income households.

In a bid to promote mass production of houses and respond to the public call for supply of affordable building materials and technologies, the Government of Kenya and other stakeholders including the National Housing Corporation (NHC) and institutions such as the University of Nairobi and the Jomo Kenyatta University have also taken initiatives to research on and promote the use of non-conventional building materials and technologies.

Already, in the late 1960s the Government of Kenya, with support from the SIDA, established a Housing Research and Development Unit (HRDU) at the University of Nairobi. Later HRDU was transformed into HABRI i.e. a full-fledged research institute (the Housing and Building Research Institute) with expanded mandate and functions that include matters that concern research on and dissemination of findings on construction industry, Therefore, HABRI became a key research institution on low-cost housing and appropriate technology (Eresund, 1997).

Therefore, at the University of Nairobi, the School of Built –Environment is the unit that is responsible for research on building materials and technologies. In 2012, NHC identified and resolved to build a factory to manufacture and supply Expanded Polystyrene (EPS) panels. This factory is intended to produce quality and affordable construction materials (panels) using the new technologies that can facilitate provision of adequate and affordable housing. The EPS panels are intended to substitute traditional materials such as blocks and stones used in erecting walls, stairwells, floors and roofs and are expected to reduce construction periods as well as direct and indirect building costs.

EPS panels are considered favourable material for construction because they meet several criteria including affordability, availability, safety, security and efficiency in terms of construction speed. Apart from these qualities, the use of EPS panels is said to have other positive impacts including: employment creation; environmental conservation and support of mass production of housing. In addition, it is quite easy to work with EPS panels during the erection phase; in fact EPS allows easy creation of necessary spaces such as openings, plumbing and electrical fixtures before the application of concrete. Other characteristics that have made it advantageous to use EPS as a new affordable construction material and technology in Kenya include: high load bearing capacity at low weight; sound, fire and heat insulation; long life and low maintenance and light weight and economic construction.

In an endeavour to promote affordable housing country-wide the Department of Housing in the Ministry of Lands, Housing and Urban Development has established in all Counties and Sub-Counties "Appropriate Housing Technology Centres" with machines for making building materials such as interlocking soil cement blocks and bricks and stabilized soil cement blocks. Cinva-Ram type of manual compress machine is often used to produce blocks/bricks.

The interlocking soil-cement and blocks have several advantages over conventional materials. For instance, being made of soil, often they are easily made at the construction site; they are environmental friendly as they are not kiln fired, the production is labour intensive and thus has high potential to create employment and income.

In order to create favourable legal framework for use and promotion of non-conventional compressed materials such as soil cement blocks and bricks, initiatives have been taken to

embark on participatory review of the building codes. Code 95 which was officially adopted by the Government in 1995 allows the use of popular and innovative materials and alternative building materials. At present, this code is being revised; the review is intended to permit the use of new innovative building materials such as PVC roofing sheets, interlocking bricks and pre-fabrications etc. Ultimately, the aim is to facilitate fast and effective delivery of affordable housing to meet the demand.

Despite initiatives taken to promote non-conventional building materials and technologies their use in housing in Kenya remains limited. This is primarily because the use of non-conventional materials and technologies such as interlocking soil cement bricks and blocks is often associated with the poor. Also there is a misconception that the final product is of low or inferior quality. Whether or not the review of the building code will make a difference remains to be seen. Suffice to note that the misconception about non-conventional materials is a problem that has been observed in several other countries.

4.3 Rammed Earth and Compressed Earth Blocks in Zimbabwe

Prior 2004, the Zimbabwean Housing Standards and Control Act and Model Building By-laws, the instrument governing housing development, did not allow the use of non-conventional materials such as farm bricks and stabilized soil blocks. Following the amendment of the key provisions (through Circular No. 7 of 2004), the use of non-conventional materials was authorized, primarily because the standards and regulations that existed before the review tended to exclude the urban poor from urban housing. Research has shown that the use of non-conventional building materials and technologies such as rammed earth (RE) and compressed earth blocks (CEB) makes housing cheaper by about 40 per cent compared to the use of conventional systems (Zami and Lee, 2009).

Discussing the inappropriateness of the pre - 2004 Housing Standards and Control Act and Model building By-laws, in Zimbabwe, Mafico (1989) argues that the standards had become an end in themselves because they were too static and not responsive to the changed socio-economic conditions (especially high poverty levels – *authors' addition*) in the country. The main qualities of CEB and RE which make them attractive and suitable for affordable housing include low construction costs; earth is easy to work with using tools and limited skills; it thereafter facilitates self-help in housing (Kataregga, 1983), has excellent strength, and requires little use of energy and deployment of simple skills and tools. In addition, it has good acoustic and adaptability to the micro-climate prerequisites. That is, earth based materials are good insulators (Cassel,1993). CEB and RE are reported to pollute 5.5 times less than concrete blocks and consume 15 times less energy than burnt or kiln bricks (Zami, 2008).

The changes and provision of the Circular No, 7 notwithstanding, some of the principal Acts especially the Regional Town and Country Planning Act remain too stringent, suggesting that

review remains inadequate in terms of facilitating expedition, development, use of non-conventional materials and technologies and facilitating promotion of affordable housing.

However, despite the lukewarm altitude towards non-conventional building materials and technologies, stabilized soil bricks, CEB and RE are extensively used in promoting affordable housing or the low income housing especially those built by private individuals. Earth materials and pressed and rammed technologies are largely used for walling, while micro-cement tiles are for roofing. Following the use of rammed earth (RE) and compressed rammed earth blocks (CEB) several earth projects have been launched and rolled out throughout Zimbabwe.

4.4 The Burnt and Sun Dried Bricks/blocks in Zambia

The Zambian National Housing Policy (1996) promoted and encourages the use of locally available building materials. But, formal housing delivery programmes including housing projects undertaken by the National Housing Authority on low cost housing have not adopted strategies to improve and promote the use of local building materials such as clay blocks and bricks and sun-dried clay bricks. However, the informal housing sector, which currently comprises over 70 per cent of the urban housing stock, has extensively used non-conventional building materials and technologies to include kiln fired, clay blocks and bricks and sun-dried bricks. Using these technologies and materials, the informal sector is reported to have been able to deliver five times more housing than conventional materials and technologies (Mwango, 2007).

In this respect, the informal sector use of locally available materials and technologies in Zambia, like other countries in the region including Namibia seems to offer one important lesson that despite not being officially acknowledged, non-conventional materials and technologies have huge untapped potential and are making in-roads in housing delivery particularly, among the poor.

4.5 Non-Conventional Building Materials and Technologies in Sudan

Residential areas in Sudan are grouped into four categories namely, the 1st, 2nd, 3rd and 4th class areas. The first three zones refer to residential areas that depict socio-economic groups namely high and medium income; the limited income group and low income group respectively. In addition there are also informal housing areas; most of these are in the peri-urban areas, where the use of traditional materials or 4th class is dominant.

Following these housing categories, building materials in Sudan are classified as follows:

a) *Modern materials*: refer to concrete, red brick with cement mortar; cement blocks and corrugated iron sheets. These are materials that are prescribed for housing development in the first and 2nd class housing areas.

b) *Traditional permanent materials*: these include red bricks combined with mud bricks and mud construction (walls); and sticks, thatch and mud (roof) - they are largely prescribed for 3rd class housing areas.
c) *Traditional materials*: thatch for walls and roofing; or thatch and mud- these are materials that are commonly used in the 4th Class areas.

It is, however, noteworthy that earth is the main building materials for most Sudanese, even in urban areas (Ahmed, 2007). Approximately between 80% and 90% of urban and rural areas respectively use earth and timber materials. The use of bricks in house construction is an old tradition (Lee, 1974) which was abandoned by the Arabs but later re-introduced by the British. A mixture of building materials such as brick with mud mortar or brick (exterior) and sun dried brick (interior) with mud mortar is also extensively used in contemporary house construction activities.

The main non-conventional materials that are commonly used in Sudan for roofing include corrugated iron sheets, corrugated fibre cement sheets, reinforced concrete roofing slabs, timber boarding and fired clay tiles.

Research on low- cost building technologies and materials in Sudan started since the 1960s, when the Building and Roads Research Institute (BRRI) at the University of Khartoum was established. The establishment of the National Council for Research (CNR) in the early 1970s marked the turning point for research activities in Sudan. NCR later evolved into an umbrella organization for all research institutions (Ahmed, 2007). Most of the research activities on the use of earth as a building material have focused on treatment of earth (ramming), mechanical stabilization (compressing) and or chemical stabilization (cement, lime, gypsum, bitumen and pozzolana).

Some of the major research achievements in building materials and technologies in Sudan, include studies on rammed earth (RE), compressed earth blocks (CEBs) and stabilized soil blocks (SSBs), low cost roofs, low cost foundation, foundation in clay soil, brick production using gas kiln, cement placement with lime and pozzolana. In addition, there have also been research activities in block making machines. Generally, research in roofing systems has been scanty. Underscoring limited research works on building materials, NCR (2002a) reports that over a period of 20 year, that is, from 1970s to the end of 1990s, only 16 publications were produced. On the other hand, due to ineffective dissemination of research results, most of the research results remain in shelves of various ministries and institutions. Subsequently the use or application of appropriate low cost building materials especially in the housing sector remains very low.

4.6 Use of Locally Available Building Materials in India

In India the construction industry is one of the largest industrial sectors in terms of economic expenditure, volume of raw materials and products manufactured, employment generated, and environment impact. The steadily increasing demand for energy-intensive building materials like burnt bricks, steel, glass, cement, aluminium, plastics and so on is projected to increase with the population. For instance, brick making activities to meet present and future demand is expected to lead to enormous loss of top soil of arable land. Besides, the huge energy demand for the production of building materials put to question the sustainability of the above mentioned building materials. This is particularly because slowly but steadily production of building materials is increasingly moving from highly decentralized and labour-intensive methods and processes of production to centralized machine driven/industrial mode (Reddy, 2004). Extensive use of non-conventional materials will therefore not only drain energy resources but also adversely affect the environment.

In India, research on alternative affordable building materials and technology has largely focused on energy conservation, concern for environment, minimization of transport cost and maximum use of local skills, re-use of industrial and mining waste and recycling of building materials. The Application of Science and Technology and Rural Areas (ASTRA) Program was established in 1974 as an integral part of the Indian Institute of Science in Bangalore. The Institute was later renamed the Centre for Sustainable Technology; and it is one of the leading institutions involved in research in building materials and technology. One of the key functions of ASTRA is to research on and develop environmental friendly, energy efficient, simple and sustainable technology that optimizes utilization of local resources and skills (ibid).

Since the mid-1970, therefore, research and development activities undertaken by ASTRA have involved not only the production and dissemination of sustainable building materials and technology, but also involved field trials and training (capacity building). During the last two and half decades, ASTRA has developed innovative building materials and technologies that include stabilized mud blocks, steam-cured blocks (mixture of lime, industrial waste/fly ash, clay and sand), fine concrete blocks, rammed earth blocks, mud concrete blocks, lime and pozzolana cement, soil lime plaster, composite mortar for masonry, composite beam and panel roof, reinforced brickwork/tile work for roof, rammed earth foundation. During the period, over 12,000 units were built using this alternative technology.

Despite the seemingly promising success achieved by ASTRA, research and development efforts in the area of appropriate and affordable materials in India is still limited. There is therefore a large scope for research and development in developing and promoting affordable building materials and technologies particularly, with reference to optimal building design and planning practices, understanding the demand and growth of the construction climate, assessing region availability of local resources, raw materials/traditional for developing and manufacture of

building products; and not least, developing building alternative technologies to meet regional specifics (Reddy, 2004).

4.7 Emerging Issues

1. There is an increasing acknowledgement that the conventional housing materials and technologies are unaffordable, particularly by low- income urban households. At the same time, there is much evidence to testify that locally available building materials and technologies are being informally used to facilitate access to shelter to particularly the poor.
2. Local building materials and technologies revealed in the case studies (including RE, CEB, kiln and sun dried clay bricks/blocks) seem to be particularly used in poverty stricken communities. These are also found to be affordable and better suited to climatic conditions subsisting in the case study countries;
3. Although the information and data available could not show the quantitative impact of the largely informal use of the locally available materials and technologies such as burnt and kiln bricks, stones, rammed earth (RE) and compressed earth blocks (CEB), sun-dried bricks or blocks, the literature show that these have made a difference in providing accommodation among the poor. Thus one could argue that without these materials housing conditions for the poor in these countries would be worse.
4. One of the case study countries, namely, Kenya, points to an interesting finding concerning the use of EPS panel as a new non-conventional building material and technology. The EPS technology and materials are reported to be favourable for construction because they meet affordability, availability, safety, security and efficiency in terms of construction speed considerations. Besides, EPS panels have high load bearing capacity; high sound, fire and heat insulation; long life and low maintenance and light weight and economic construction. This is food for thought for NHBRA and its partners to explore and break new grounds.
5. In a number of countries research activities on building materials and technologies are being undertaken by institutions that have strong research culture (i.e. universities or large national research organisations). This is an important observation that constitutes food for thought as one contemplates the future of NHBRA as a research institution.

Chapter Five

Alternative NHBRA Building Materials and Technologies

5.1 Introduction

This chapter presents the types of materials and building technology researched by NHBRA over the last forty years. Discussed also are aspects that concern economic, socio-cultural and technical acceptability of the NHBRA building materials and technology. In addition, the knowledge on extent of adoption of the materials and technologies innovated by NHBRA are also discussed.

5.2 Types of Materials

There are two major categories of building materials that are used for low cost housing in Tanzania. The first category is that of locally available that entail the use of local craftsmen and skills in moulding them to meet functional requirements of a shelter. The second category is that which requires technology both in producing the materials and in moulding them. Invariably the locally available materials have a high resilience towards weather changes as they are adaptable to the local conditions. However, if the use of locally available materials is unchecked, they could be a cause of depletion of the green structures and destruction of the environment. Generally, it is the combined use of these types that has over the years enabled communities towards affordable housing both in terms of cost and technology. According to Mwakyusa (2006), there are at least 11 different types of locally available materials that have been in use over the years. The NHBRA has carried out studies on some of these and implemented projects as already summed up in Table 1. In a large number of cases, NHBRA has also carried out laboratory experiments on particular materials, trials and applications some of which have been published.

There is clear evidence that despite the fact that NHBRA owns a number of building research laboratory equipment, it has carried out very limited work in testing of building materials for external organisations and individuals. Available information from the NHBRA indicates a growing number of research works between 1974 and 1985 (see Table 5.1). Thereafter, there has been very little new research at least in terms of published findings. From interviews with NHBRA staff at their offices in Mwenge, it is suggestive that the NHBRA has been implementing some of the technologies in cooperation with a number of organisations and in particular community organisations as detailed in Chapter Six of this report.

5.3 Types and Evolution of Technologies

Apart from the list of materials that NHBRU and later NHBRA have worked on, there are several other organizations in the country that have worked on developing traditional materials for construction works (Appendix 5). These include the following:

i. *Bamboo*- past works on the use of bamboo in the country is limited to plumbing system. It is a light material and highly resilient to wind pressure and easy to work with and speedy construction. Bamboo has not featured in NHBRA work despite its ample abundance in some parts of the country. In some countries, bamboo technology has eased emergency housing. Modular bamboo houses developed by TRADA Technology limited are gaining popularity in several countries (Mwakyusa, 2006).

ii. *Stone:* Natural stones are available in most parts of the country; igneous, metamorphic and sedimentary rocks have been cut and used for building from time immemorial.

iii. *Sand*: Sand is fine aggregate, resulting from the natural disintegration of rock. Natural sand is available in most parts of the country and mostly obtained from the sea or from natural river beds.

iv. *Limestone*: Limestone is widely distributed in Tanzania and works well as building stone after being quarried. Once processed, it can be used as mortar, plaster material, white wash and for soil stabilisation.

v. *Marble*: Good deposits of marble exist in Mbeya region. Marble is quarried and processed to construction marble of high quality compared to some of the imported marble.

vi. *Gypsum*: This material has not been used as a building material except in the manufacture of cement. Gypsum can also be used as a plaster material (stucco), manufacture of plasterboard, and manufacture of building blocks and as bedding screed for floor tiles.

vii. *Limestone and pozzolana*": It is largely found in Arusha and Rungwe District (Mbeya Region). A mix of lime and pozzolana is as good as ordinary Portland cement; as a binder, as well as for making blocks and plastering. This makes it possible to save on cement use and thus lower construction costs.

viii. *Sisal:* sisal fibre is used as strengthening agent to replace asbestos and fibreglass and is increasingly a component used in the automobile industry, where its strength, "naturalness" and environmentally friendly characteristics are greatly appreciated. BRU Research on use of sisal started in 1978.

ix. *Agricultural and industrial waste:* A research carried out by BRU revealed underutilization of agricultural and industrial waste for housing. At Mtibwa Sugar Factory, the molasses is poured along the factory's roads so as to give a hard tarmac-like surface. Molasses can also be used to produce ceiling boards such as soft/hard or particle boards.

x. *Sawdust and Chips:* Australia sawdust and chips are used to make hollow blocks. This is a well graded mixture of wood chips and cement. Sawdust can also be used in the production of clay bricks and manufacture of magnesium oxychloride flooring comprising 30% sawdust.

xi. *Coal cinder as building material*- a research at Kiwira Mines in Mbeya Region has revealed possibilities for coal mines waste.

5.4 Economic, Socio-Cultural and Technical Acceptability

The evolving technologies and improved use of local materials for construction are perceived differently in the society. There is clear evidence that the perceptions are shaped not only by the income levels of the people but also by the historical epochs and facts of the time. Whereas for example large house (bungalows of up to 175sq.m) with reinforced concrete slab were fashionable and symbol of wealth during 1960s-1990s in almost all the major cities in the country, today such houses are frowned upon. Similarly, whereas between 85 percent and 90 percent of the rural houses were in 1969 built entirely of local materials (Lemunge,1978), the proportions have significantly changed since then with over 45 percent of the rural housing now being built of industrial materials such as corrugated iron sheets and cement products (URT, 2014). In the following section an outline is made on the acceptability levels for the building materials and technologies that have been developed by the NHBRA by the different social groups.

Low Income Groups

Lemunge (1978) correctly observes that the NHBRA has had to concentrate on rural housing improvement over the years. This was necessary not only because of the then reigning socialist ideology at the time which favoured rural development strategy, but more importantly, this was the sector that was experiencing serious problems in terms of housing quality and durability. The research that NHBRA has been concerned with was to do with improving local materials which Lemunge (1978) defines as those materials that are 'local to the building site'. For purpose of this study, perception of low income group is that which reflects views of the majority of whom are considered to be poor living on less than $1 a day. The notable nature of housing problem in the country is not total lack of shelter, but rather as Lemunge (1978) and Kironde (2002) observe quality and durability. As a result, acceptability of innovative technologies in improving the materials whether induced by purposive research or efforts by the government or not, has been quietly expressed in the country. This is reflected in the changing morphology of housing structures in the country and the high demand for use of 'permanent' building materials such as roofing sheets. A steady improvement of the housing quality among the low-income household is generally observed with an increasing number of artisan *fundis* embracing skills and materials that are not necessarily local in their areas.

It is important to stress the meaning that is ascribed to 'local materials'. There is no common understanding of local building materials in the country, mainly on account of the diverse climatic and geological formation of the country. As a result, whereas some parts of the country would consider burnt bricks as the ordinary available local materials, in some other part of the country this is tantamount to an imported material together with the technology that is required to make it and use it for construction. The interesting observation is the fact that amongst the low-income households in the country, there has been a transfer of knowledge and adoption of local materials from one geo-location area to another through interaction of the people. This

transfer of knowledge and technology has been made possible through cultural mixes of the people e.g. intermarriages but also from being aware of the economic benefits that the transferred technology has to the host community.

Table 5.1 attempts to trace the use of different materials for the main elements of construction and shows a general absorption of the materials mainly on account of interaction of the population with commentary on whether these efforts have been complemented with particular research. The argument put forward is the acceptance of any particular materials and technology is heavily influenced by what the local population perceives as improving standards. Whether any use of materials by any society had cultural significance is difficult to ascertain.

Table 5.1 Evolving building materials and their adoption outside their origination areas

S/No	Element	Main Types	Original Areas	Adoption Nationally	Remarks
1	Walls	Entirely organic materials –poles, reeds and grass(40% of rural housing in 1969)	Throughout the country	In most rural areas	Short lived, vulnerable to insect attack, disappearing. Not widely accepted
		Mud and Poles, animal dung plaster(40% of rural housing in 1969)	Wet and cold areas	Widely spreading with improved plaster mixes	Improved through stabilized soil technologies.
		Walls made from soil only (15% in 1969)	Limited areas in the country (dry areas)	Widely, improved in form of bricks, adobe technology (use of dried bricks, earth straws)	Durable, improved versions. Some research has focused on improving the binding e.g. lime and pozzolana.
2	Roof	Mud slab, flat roof deck	Dry areas	Limited	Not durable, good heat insulation properties, disappearing.
		Poles and Grass thatch, conical shaped	Wet areas	Limited, being replaced with corrugated iron sheets	Attractive if well knitted, disappearing skills.
		Slates, abundantly available in several parts of Tanzania but rarely used	Not common	Limited	Potential use of natural stones as slates for roof cover, needs for research.
3	Foundation	Off ground (no foundation at all), 95% of rural housing in 1969	Widespread for all types of rural housing	Not spreading, limited	Considered poor technology, discouraged.
		Timber footing (up to 30cm deep holes, ramped earth)	Wet areas	Not spreading, limited	Discouraged, replaced with simple strips of concrete or stones.
		Stone cobles with mud	Rocky areas	Limited,	Durable

S/No	Element	Main Types	Original Areas	Adoption Nationally	Remarks
		bonding	for relatively economic powerful households	expensive materials (not local in most locations)	
4	Joinery works (Doors, windows)	Poles and grass/straws without locks	Throughout the country	Disappearing, not strong	No security guarantee, no research to improve quality
		Timber battens, loose hinges	Throughout the country	Improved versions across the country both in size and appearance	No documented research on ways of improving for security
		Timber panels, decorative, with locks	Around Coastal areas, Arabic influence, heavy doors	Limited, disappearing	No research on doors and windows
5	Flooring	Ramped earth (siliba) with raised plinth wall around the house	Throughout, the country except raised floor/plinth limited to coastal, western Tanzania	Limited adoption in other areas, being replaced with sand cement screed	Not good for hygiene, being discouraged
		Stone with ramped earth finish	Limited to areas where natural stones are available	Limited, laminated sedimentary rocks from Tanga aptly available for paving as well	Durable and possibility for polishing. No research on paving stones in Tanzania
6	Pit-latrines Structures	Simple pits with poles and grass enclosure, no roof cover	Few areas around the country	Encouraged in 1960s *(Mtu ni Afya)* and widespread	No documented research on materials for local materials for pit- latrines
7		Simple Pits with Tin Tank	Wet areas	As above	Improved pit latrines concept developed, but no research in the area.

Source: Fieldwork, April 2014

From the interviews carried out for this study, it has been observed that individuals and even communities in the low income bracket are more likely to adopt use of a technology and building materials if they are exposed to it. In some of the projects sites visited, (e.g. Tarime, in Mara Region, Chamazi in Dar es Salaam City and Miyuji in Dodoma Municipality etc), it was evident

that those who were privileged to be part of the NHBRA experiments had taken full advantages of the acquired skills in improving their housing. As reported in Chapter 8 and 9 in this report, the NHBRA has managed to reach only a fraction of the population and therefore the impact has been minimal. On the other hand, from Table 5.1, it is noted that communities whether or not are influenced by a particular project, they would naturally progress in improving their own way of realizing building projects through improving materials and ways of mixing them.

5.4.1 Materials Used by Medium and High Income Groups

The term "medium income" as used in this study refers to individuals with Regular incomes and would include graduates and most civil servants with monthly average earnings above TShs 1,200,000 (approximately USD 710). In terms of this group's perception of the use of alternative building materials and technologies, it is important to reflect on the individual efforts towards accessing housing. Unlike the bulk of low-income group, individuals in this income bracket are more enlightened and thus likely to be aware of the on-going research work, available materials and technologies. They can also access information on available sources of financing their housing needs. As a result, therefore, individuals in this group are not utterly constrained in their decisions on what materials to use in their house construction.

From the interviews, it was intimated that almost all middle income individuals who had developed their housing, used conventional materials and technologies that were readily available to them. These individuals had no reason to doubt neither durability nor appearance of the materials that they had to buy for their home building. For instance, one of the individuals interviewed noted this:

> "*…why should I not use the materials that are popularly used by the majority of my colleagues? Why consider materials that I neither see any of my friends using nor are they available in the shops where I buy…?"* (Interview with Joes, May 29th 2014, Mwenge, Dar es Salaam)

Further interviews with seasoned architect and quantity surveyors echoed the foregoing, noting:

> "*why should I prescribe to a client material and technologies that he/she can not readily find in the market. The materials of NHBRA have no internationally recognized standards"*[1]

Apparently, the cost of materials was not an important consideration in the selection of materials to be used.

[1] Interviews conducted in April 2014 at Ardhi University

It was striking that a large number of those interviewed were aware of NHBRA as a building research organization, but did not consider the research findings from NHBRA targeting them. They see NHBRA as an organization working towards improving housing for the rural people. Even when it was clarified to the respondents that the NHBRA was researching on cheaper and appropriate technology in building materials that assures quality housing, there was still hesitation on why had the NHBRA been confined to the basic materials for simple house construction.

> "*…a good housing is not about the walls and roofs, why isn't NHBRA researching on those materials that give a house an attractive appearance like the plastic mouldings that Chinese Businessmen are supplying into the local market? Why have they not worked on electrical and plumbing appliances that will improve energy performance of the housing units?*[2]*,,,*"

Although the sampled respondents may not necessarily be representative of the medium income group, there is however a reason to believe alternative building materials and technologies may not be an attraction to the socio-economically better off members of society. As observed by Lemunge (1978), it is unlikely that the most affluent would consider the use of alternative materials for their housing on basis of costs.

They are more likely to consider adopting such materials and technologies for reasons of aesthetics. It was intriguing, therefore, to find out respondents views of NHBRA materials in that regard. None of those interviewed considered the materials as meeting set standards for aesthetics. There was expressed concern on lack of fine polishing for the NHBRA materials which one of the respondents blamed to be emanating from the prejudices that the NHBRA is targeting poor people.

5.4.2 Social Acceptability of NHBRA Technologies

There are at least four possible indicators if one was to evaluate social acceptability of building materials and technology by the society. These are durability, wastages, aesthetics and cost. As discussed earlier, cost savings in the use of materials and technology is paramount and would in many instances prejudice the other indicators.

But this is only true against existing income levels of the particular community and information available on the cost savings in the use of the materials and technology. From the studies made and despite the obvious cost reduction associated with the use of NHBRA Materials and Technology (M&T), there is no evidence to show that the M&T have been widely used in the country, suggesting either low level of acceptance particularly among middle and high income social groups, and/or unawareness/unavailability of the materials and technologies among low incomes.

[2](Interviews with a middle income resident (Mr Joe) in Mikocheni, Dar es Salaam, May 2014),

Durability is an important consideration in any building project mainly on the account of the long time it takes to realize a housing project and the associated costs for keeping and maintaining the housing over the entire life of the house. NHBRA M&T have been developed under laboratory conditions and there is scientific proof that they meet durability tests. Despite the fact that some of the demonstration houses have been too small and succumbed to deterioration due to high exposure (as seen in Plate 5.1), there is a general consensus amongst those interviewed that NHBRA materials and technologies are improved versions of the natural building materials that are durable. Those interviewed singled out the interlocking bricks, stabilized soil bricks and the reinforced sisal roofing sheets as good examples.

However, the adoption of the NHBRA technology by allied institutions such as the National Housing Corporation and the centre for Community Initiatives in the production of building materials and house construction is a testimony of the increasing acceptability of the NHBRA materials and technology by the wider side of the society.

From the interviews and visits to the 16 sites, generally, M&T by the NHBRA has been observed to offer:

a) Improved environmental quality inspired by the NHBRA designs in terms of room sizes and general layout
b) Acceptable use of the nature's products thus contributing towards conservation of the natural environment; and
c) Healthier buildings as the improved materials are processed more to exclude microbial growth and vermin.

5.5 Knowledge and Extent of Adoption

The extent to which the NHBRA M&T has been adopted in the country judged from the projects implemented by the NHBRA is suggestively very low. However, when one looks at the evolution of the use of building materials during the last four decades in the country, there is a general trend towards the use of non-conventional building materials that are close affiliates of the materials that have been researched and reported upon by NHBRA. For example, the use of interlocking bricks or hydro-form bricks is now much common in cities like Dodoma and Dar es Salaam, both for the residential and non-residential sectors. Unfortunately the NHBRA does not have patent rights to the M&T it has developed and therefore may not be justifiable to claim where M&T resembling those at the NHBRA have been observed around the country then they are products of the NHBRA. Given the fact that NHBRA as a government agency has shared its work with communities as discussed in Chapter 8 and 9 as well as prepared the Building Catalogue, it is tempting to suggest that NHBRA is gradually a growing influence.

There are two key influencing factors, which M&T as developed by the NHBRA, which are of practical value to the society:

a) Loss of traditional skills and in particular those dealing with ramming earth, thatching and use of timber in construction. These skills have been acquired over the years through apprenticeship. Fortunately a more formally organized vocational training is available through the VETA, which indeed seeks to modernize the skills. The NHBRA technologies not only improve the quality of the products but also efficiency in the production process.
b) The use of NHBRA M&T in house building is commensurate with other needs in the society which decry for improved hygiene and protection from effects of weather. The NHBRA M&T are adaptable to modern living in urban areas and is increasingly being acceptable in the rural areas.

5.6 Emerging Issues:

1. There are many locally available building materials that are widely distributed in the country. However, NHBRA has only researched 11 different materials and developed 5 technologies over the last 40 years;
2. Generally, NHBRA materials and technologies are accepted and considered environmentally friendly and superior to what low-income households uses;
3. Although technologies developed by NHBRA have improved over time, some households, (middle and high income households) consider NHBRA materials and technologies to be of inferior quality and poor aesthetics;
4. Key determinants of acceptability include cost, durability, aesthetics and availability; and
5. There is an increasing competition between NHBRA materials and technologies and others in the market.

Chapter Six

Availability and Affordability of NHBRA Materials and Technologies

6.1 Introduction

The appropriateness of a building material or construction technology can never be generalized. Preference is often based on materials that are available locally rather than imported ones. Where cheap materials are available in large quantities, the preference is also higher. The place of production process is also important, which means production at site can be more attractive and economical since transportation cost will be minimised.

In terms of technology, considerations on whether the material requires special technology or whether it can be produced locally at lower costs are also critical considerations. Generally, a good technology is that which produces a durable and quality product at a reasonable cost. In addition, often preference is given to a material with low energy input, with less wastage and pollution. In this regard users also check whether there is an alternative for other better materials. Materials and technologies ought to also comply with the local climatic conditions. And the best technology is the one that can be easily understood by the local artisans/workers with adequate skills. Running and maintenance cost of materials are also a critical considerations when making a choice.

6.2 Characteristics of Materials and Applied Technologies

Characteristics of Materials

The characteristics of building materials (including NHBRA materials) are analysed in terms of their availability (source), basic properties and functional requirements. Basic properties of building materials include density, strength, thermal properties, insulation properties, acoustic properties, optical properties, deformations, deterioration, appearance and electrical properties. Functional requirements include durability, structural safety, health, fire resistance, buildability, appearance, environmental friendliness, specification and standards and quality. Quality refers to the property of a selected material to perform well, meet and fit the desired purpose.

Properties of NHBRA Interlocking Bricks and FRC Tiles

Based on available information, NHBRA products exhibit adequate strength, structural safety and provide an optimum indoor thermal comfort. The materials are also safe and easy to work with.

There are, therefore, good reasons for choosing these materials which are regarded as less energy intensive, and therefore do not consume so much energy during production. They also have better attractive appearance especially when compared to, for instance, sand-cement blocks.

This gives them high aesthetic value, and can perform well in varied climatic conditions. However, so far no formal standards and building codes for these materials are available.

Advantages of NHBRA Interlocking Bricks include:

i. Good appearance, i.e. higher aesthetic value;
ii. Environmental friendliness;
iii. Adequate strength;
iv. Low production cost;
v. Useable in different soil types, based on local conditions;
vi. Production on site (in-situ production) is possible;
vii. Building process is faster compared with conventional materials; and
viii. Minimum cost of external plastering;

Advantages of NHBRA Sisal Fibre Roofing Tiles (FRC) include:

i. Low production cost;
ii. Good use of some of the waste products from the sisal industry;
iii. Extended life performance;
iv. Good appearance, i.e. aesthetic value;
v. High indoor thermal comfort;
vi. Require minimum;
vii. Safe rain water can be harvested with SFRT roofs;

6.2 Availability and Affordability of Materials and applied Technology

During the field survey, it has been established that NHBRA cement stabilized interlocking bricks and interlocking brick pressing machine technology are used in most of the districts, towns and municipalities visited during the field studies. These towns include Tarime, Babati, Biharamulo, Handeni, Dodoma, Bagamoyo, Njombe, Mbeya, Iringa and Morogoro.

6.2.1 Availability and affordability of Materials

Raw materials for the products innovated by NHBRA are in most cases abundantly available in many localities in the towns and regions visited. In fact, in many areas the traditional building technologies and materials used in the areas visited can easily adapt the NHBRA materials and technologies (Table 6.1 and Appendix 7).

The raw materials used for the building or house construction activities were in most cases available within or close to building site. However, an exception is with the CCI project in Miyuji, Dodoma, where sand s for the ongoing low-cost housing construction is being imported from Mituka, 4 km from the project site while clay soil is from Mzakwe area, about 5kms from the site. In principal, the traditional building materials used in many of the areas visited during

the field study are relevant to the materials and technologies developed and promoted by NHBRA.

Plate 6.1: Locally produced interlocking bricks (right) and burnt bricks (left) in Morogoro(using the same raw material, suitable soil)

Source: NHBRA, 2014

In Dar es Salaam, NHBRA gets raw materials for making interlocking soil-cement bricks from nearby sources distances. For example, crusher dust which used as a raw material is available at reasonable prices at Kunduchi, Bunju and Boko quarries. At present, a 12 cubic metres capacity truck costs 150,000 TShs and can be used to produce approximately 2000 bricks.

Table 6.1: Availability (Occurrence) of Natural Building Materials in Selected Regions

S/NO	**Building Materials** / **Region**	**Limestone**	**Gypsum**	**Clay**	**Soil / laterite soil**	**Sand/ stone chippings**	**Pozzolana**	**Pumice**
1	**Arusha**	Yes	NA	Yes	Yes	Yes	Yes	Yes
2	**DSM**	Yes	NA	Yes	Lat. soil NA	Yes	NA	NA
3	**Coast**	Yes	NA	Yes	Lat. soil NA	Yes	NA	NA
4	**Dodoma**	Yes	Yes	Yes	Yes	Yes	NA	NA
5	**Iringa**	Yes	Yes	Yes	Yes	Yes	NA	NA

6	**Kigoma**	Yes	NA	Yes	Yes	Yes	NA	NA
7	**Kilimanjaro**	Yes	Yes	Yes	Yes	Yes	NA	Yes
8	**Lindi**	Yes	Yes	Yes	Yes	Yes	NA	NA
9	**Mara**	Yes	NA	Yes	Yes	Yes	NA	NA
10	**Mbeya**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11	**Morogoro**			Yes	Yes			
12	**Tanga**			Yes	Yes			
13	**Songea**			Yes	Yes			
14	**Mwanza**			**Yes**	**Yes**			
15	**Manyara**			**Yes**	**Yes**			
16	**Geita**			**Yes**	**Yes**			

Source: Fieldwork, April 2014

Key : Yes = Available NA = Not Available

6.2.3 Affordability Level based on Household Income

Household income influences the use of NHBRA materials and technology. In most urban areas, the affordability is anticipated to be higher than in rural areas due to the income level. Table 6.2 represents collected information on household income (HBS 2007). The households' incomes are generated from a wide variety of sources. From the Table 6.2, Dar es Salaam is leading in terms of the mean per capita income, followed by other urban areas and last is rural areas.

Table 6.2: Mean per capita household income per year in TZ Shillings

Dar es Salaam	Other Urban	Rural	Mainland Tanzania
80,144	64,231	28,418	39,362

Source: HBS 2007

Based on data from HBS (Table 6.3), the mean percentage share of consumption by expenditure category indicates that food purchased lead in both urban and rural areas, followed by other non-durables and durables.

Table 6.3: Mean expenditure per capita by category in Tanzanian Shillings[3]

Category	2000/01				2007			
	Dar es Salaam	Other Urban	Rural	Mainland Tanzania	Dar es Salaam	Other Urban	Rural	Mainland Tanzania
Food - purchased	10,301	7,114	3,118	4,085	18,731	12,650	5,944	8,079
Food – not purchased	368	876	2,375	2,051	418	1,717	4,612	3,789
Total food	10,668	7,989	5,492	6,137	19,149	14,367	10,556	11,868
Durables	1,892	1,099	484	650	2,738	2,090	767	1,147
Medical Expenditure	569	338	190	232	816	490	286	362
Education Expenditure	974	431	138	227	2,387	1,059	248	550
Other non-durables	7,006	4,253	2,146	2,718	14,003	8,217	4,368	5,764
Telecommunications	304	74	6	33	2,980	877	194	522
Total consumption expenditure	21,415	14,185	8,456	9,997	42,074	27,100	16,418	20,212

Note: 'Food not purchased' includes food produced for home consumption, received as payment in kind or gifts etc.

Source: HBS, 2007

6.2.4 Availability and affordability of Technology

The technology used in most of the projects visited is in principal, available through NHBRA and trained agents. In the past NHBRA had been conducting sensitization and training seminars in various regions where the materials are available, in order to impart knowledge and awareness

[3] Source HSB (2007)

among the local people. From these programs, the trained persons were engaged to train others in the local communities. Thus, NHBRA trained persons in turn trained their fellows, especially the youths, organised under building brigades. Training programs by NHBRA are normally sponsored by local authorities or private companies, the latter pay for the training as part of their social corporate responsibility.

The NHBRA interlocking brick pressing machine (IBPM) technology has been used in most sites visited to produce bricks for the local projects. In some projects (i.e. in Morogoro and Dodoma), the machines used to produce the bricks are still available for continued local production of bricks. This is often the situation whereby arrangements are made by the local community or project clients to purchase the (IBPM) machines from NHBRA.

In some projects cases, the machines were taken by NHBRA and sent to other projects. This was for instance noted during the fieldwork studies in Tarime and Babati. And in cases where the machines were left back, they are rented by individuals or shared by the respective villages' communities.

Plate 6.2: NHBRA Interlocking Brick Press Machine manufacturing yard

Source: NHBRA, 2014

NHBRA machines are generally affordable. The current prices are between TShs 400,000 and TShs 600,000 for the IBPM and TShs 250,000 for Tile machines. The machines are supplied with a free user training package.

Table 6.4: Cost comparison for NHBRA materials (Walling and Roofing)

S No	Material	Cost/Square metre (TShs)	2 BRs house GFA= 50 sqm	3 BRs house GFA=70 sqm
			External wall Area = 53 sqm Internal wall Area = 49 sqm	External wall Area = 63 sqm Internal wall Area = 59 sqm
1	**Walling**			
1a	(i) Cement and sand	18,400	1,876,000	2,244,800
	(ii)Plaster and painting on two sides	10,000	2,040.000	2,440,000
	Total		**3,916,800**	**4,684,000**
1b	(i) Interlocking bricks	13,800	1,407,000	1,683,600
	(ii) Plaster and painting on one side	10,000	1,510,000	1,810,000
	Total		**2,917,000**	**3,493,600**
2	**Roofing**			
2a	(i) Corrugated Iron Sheets (G28, 3x0.68m)	14,200	894,600	1,249,600
	(ii) Treated softwood	4,000	252,000	352,000
	Total		**1,146,600**	**1,601,600**
2b	(i) NHBRA (FRC) Tiles 0.4x0.2m	1,700	737,100	1,029,600
	(ii) Treated softwood	6,000	378,000	528,000
	Total		**1,115,100**	**1,557,600**

Source: Fieldwork, April, 2014

From Table 6.4, it is evident that using NHBRA materials cost s less than using conventional materials. Further, it should be noted that the production of NHBRA materials will be even cheaper when the production is done on site. However, the costs of roofing are not very different, and this is due to the fact that roofing with NHBRA tiles requires more timber than CGI sheets.

Table 6.5: Availability of NHBRA materials and technologies in the areas visited

SN	TOWN/AREA	MATERIAL	TECHNOLOGY	REMARKS
1	Dar es Salaam/ Coast Region	Stabilised Soil cement inter-locking bricks. FRC tiles.	Interlocking press machine. Stabilised soil pressing machine. Tile vibrators. Tile moulds.	Materials and technologies available

2	Bagamoyo	Stabilised soil cement blocks. Soil cement inter locking bricks.	Interlocking press machine. Stabilised soil pressing machine. Tile vibrators. Tile moulds.	
	Kabuku	Stabilised soil cement blocks.	Stabilised soil pressing machine. Tile vibrators. Tile moulds.	Training and demonstration only, machines not available
4	Tarime	Soil cement inter- locking bricks.	Interlocking press machine.	Machines sent to other projects, not available for local production of bricks
5	Babati	Soil cement inter- locking bricks.	Interlocking press machine. Concrete vibrators	
6	Geita	Inter- locking bricks		
7	Dodoma	Stabilized soil cement inter-locking bricks. FRC tiles	Stabilized soil cement pressing machine. Tile vibrators. Tile moulds.	Machine available
8	Mvomero / Kingorowila/ Morogoro	Soil cement inter- locking bricks. Burnt interlocking bricks.	Interlocking bricks press machine.	Machine loaned out
9	Iringa	Soil cement inter-locking bricks.	Interlocking press machine. Tile vibrators. Tile moulds.	
10	Njombe	Soil cement inter-locking bricks.	Interlocking press machine.	

Source: Fieldwork, April 2014

Although, NHBRA is required to conduct research and promote building materials and technologies in both urban and rural areas, analysis of the documented projects, showed that NHBRA has concentrated in urban areas.

6.3 Place of production and Capacity – Interlocking bricks

The production capacity at NHBRA headquarters in Mwenge is between 600 to 700 bricks per person/ machine/day (Appendix 6). According to interviews with NHBRA, normally, the highest production output is achieved from the experienced brick makers. In upcountry regions, for example in Babati, Tarime, the production capacity reported is ranging from 300 to 500 bricks per person/machine/day.

Table 6.6: Production capacity in selected areas

S.No	Region	Production capacity (man/machine/day)	Remarks
1	DSM	600 – 700	Production at NHBRA
2	Tarime	300 – 500	Production at site
3	Babati	300 – 500	Production at site

Source: Fieldwork, April 2014

6.4 Supporting Technical Infrastructure Services

As far as the supporting infrastructure is concerned, the priority is to produce the products at the site. This is intended to reduce transportation costs. Water is a basic raw material for the production process, both in the mixing process and curing of the fresh products. So in places with water scarcity, there could be a problem of producing high quality products. A stable source of power is also required to support the vibrators, which are used in the production of sisal fibre-cement tiles.

6.5 Market Outlet for NHBRA products and Prices

Information from the field studies and interviews conducted with stakeholders in Dar es Salaam, reveal that there are generally very limited markets outlets for NHBRA materials and technologies. Apart from sales done at NHBRA headquarters, other market outlets are facilitated by the organisations/ institutions which are collaborating with NHBRA such as VETA. The coverage of the markets however remains small.

Table 6.7: Prices of NHBRA products in Tanzanian Shillings

S.No	Product	Price (per unit)	Remarks
1	Interlocking brick	400	NHBRA price
2	IBM	450,000	‘’
3	Tiles	400	‘’
4	Tiles Vibrator	250,000	‘’

Source: Fieldwork, April, 2014

The cost of the brick is TShs 400 in Dar es Salaam and TShs 600 in up country regions. However, interlocking bricks are cheaper compared to sand cement bricks, which costs between TShs 1000 and TShs 1200 per unit.

Table 6.8: Comparison of NHBAR Interlocking Brick and Sand Cement Block

S.No	Region	Prices NHBRA Brick (TShs) per Unit	Price of Sand Cement block (TShs) per unit
1	DSM	450	1000
2	Coast	450	1000
3	Morogoro	450	1000
4	Manyara (Babati)	500	1000-1200
5	Tarime	450	1200

Source: Fieldwork, April 2014

6.6 Institutions and Actors: their Roles in Promoting NHBRA Products

NHBRA has been collaborating with a number of governmental institutions, international organisations, NGOs and CBOs for several years. The collaboration has in a way contributed and facilitated the availability of NHBRA materials and technologies in some up country regions. A short list of the organisations participating in NNHBRA program and their collaboration input is presented in Table 6.9.

Table 6.9: Contribution of institutions and actors collaborating with NHBRA

S. No	NGO, CBO, Govt Inst.	Cooperation with NHBRA	Contribution towards availability of NHBRA M & T
1	TBA	Yes	Adopted and supported the use of NHBRA material and technologies in some projects
2	NHC	Yes	Adopted the technologies, training (with NHBRA, VETA) and dissemination in up country areas
3	VETA	Yes	Collaborating in training with and NHBRA and NHC for the production of the materials and technologies
4	LGAs	Yes	Adopted and used the materials and technologies (Training), Capacity building and dissemination (Mvomero)
5	Ministry (MoEVT) and LGAs	Yes	Adopted and used the materials and technologies for Staff houses/classrooms construction
6	WAT-HST	Yes	Adopted the materials and technologies for low - income housing improvement
7	JKT SUMA	Yes	Adopted the materials and technologies for materials production
8	CCI	Yes	Adopted the materials and technology, and supporting low income housing production
9	Katani Ltd.	Yes	Supports the adaptation of the materials and technologies, supplies raw materials for FRC tiles
10	Private Sector	Yes	Adopted and use the materials and technologies in house construction, and for limited sale

Source: Fieldwork, April, 2014

Regarding the role of the private sector actors, these have not been adequately involved in the dissemination of NHBRA materials and technologies.

Under normal circumstances, it is expected that innovation programs, processes and production in most cases done in partnership with the private sector. The latter include producers of building materials, and technologies and individual home builders.

6.6 Selected Cases Illustrating the use of NHBRA Materials and Technologies

Fieldwork studies were conducted in various projects where NHBRA materials and technologies have been used. Almost in all sites, the NHBRA materials used exhibit the requisite quality properties and advantages. From the field studies, it was noted that NHBRA materials are more affordable if produced at or within the project areas. On the other hand, the technologies such as interlocking press machines (IBPM) are not affordable by individual households. But where organized groups in a community have pulled their resources together IBPM becomes affordable. Selected fieldwork areas where NHBRA materials and technologies have been adopted are outlined below.

(i) The Interlocking Soil Cement Bricks, District LGA Office Block, Tarime

The project at the Tarime District Council constitutes an office building erected built using the NHBRA inter-locking soil-cement bricks. According to the council officials and other respondents met in the area, abundant availability of appropriate raw materials (suitable soils) in Tarime; attractive physical appearance of the materials, good quality and most importantly lower costs of the materials and technologies, were the key factors that the Council considered in deciding whether or not to adopt the NHBRA materials and technologies. Apart from the public office building, two private residential houses have also used the same materials and technologies. Discussions with officials in Tarime District as well as with other two individuals who have used the NHBRA materials and technologies confirmed that when compared with conventional sand-cement blocks, the NHBRA materials and technology had reduced the overall cost of a building by between 40 and 50 per cent. "You can see we have built several buildings in our district. We have noted that the use of inter-locking bricks make a significant cost – saving"[4]. It was further asserted by the respondents that the NHBRA technology and materials can easily be adopted in the entire District because the soils are quite suitable.

(ii) Inter-locking Soil-Cement Bricks and FRC Tiles: Affordable Housing Scheme Miyuji – Dodoma Municipality

The inter-locking soil-cement bricks housing at Miyuji in Dodoma Municipality is a low cost housing scheme funded by the Centre for Community Initiatives (CCI). The project commenced in 2010. The project intends to provide 500 units. CCI provided a loan to the local community group to purchase the interlocking press machines; contracted NHBRA to conduct training workshops (involving the local housing cooperative members) on how to produce and use both the bricks and the cement-sisal fibre roofing tiles in house construction. Interviews with the house-owners and other persons involved in the project revealed a strong preference and interest to use the NHBRA materials and technologies. All the respondents interviewed argued that the NHBRA materials and technologies used in the project have enormously cut down the cost of housing. They further added that, the technologies and materials are easily adaptable, primarily

[4] Discussing with District Engineer, in Tarime, District April 2014

because the sandy clay soils are available in many areas in the Municipality. The excerpt below further illustrates the point: "

.....None of us (members of the federation) is earning much, some of us are petty traders; through, but using the materials and technologies, we have been able to acquire good houses. We are very proud".

Plate 6.3: Interlocking bricks ready for use **Plate 6.4: Roofing tiles ready for use**

Source: Fieldwork, April 2014

Asked how much the 40 housing units cost, a technician supporting the project revealed that, each unit costs between 3.5 – 5.0 million TShs. (about 2, 190 – 3,130 USD)[5].

(iii) Stabilised Soil Blocks and FRC Tiles - Kabuku Village, Handeni District

In 1985, NHBRA (then BRU) conducted a training and demonstration project on the production of stabilised soil-blocks and sisal fibre re-enforced tiles for roofing in Kabuku Village. The technology propagated comprised IBPM machines. FRC tiles had to be produced using moulds. Although the selected members of the Kabuku community (which included village leaders), learnt how to manufacture bricks and tiles, the respondents reported that they had not applied the materials and technology. According to the ex-village chairman who was one of the trainees; this is because NHBRA did not provide or facilitate acquisition of the IBPM machines.

(iv)NHBRA Interlocking Bricks - Health Centre, Mnkunkwa Village, Biharamulo District

The health centre building at Mnkunkwa Village in Biharamulo district was built using the interlocking soil-cement bricks made by IBPM machines. The bricks were made by the two youth groups who had been trained by NHBRA. The African Barrick Gold funded the training of the youth groups and provided them with six interlocking brick machines. This was done as part of the Barricks' Corporate Social Responsibility. The group produced bricks and sold them to the

1. [5] Discussion with female homeowners at Miyuji (Seje Seje) Dodoma, May 2014

construction company that was contracted to build the health centre by the African Barrick Gold. The health centre project was completed in November, 2013, and the current condition of the buildings in terms of physical structure, thermal comfort and outlook is quite good. In an interview with the contractor he noted that the cost of construction for the health centre was definitely lower than if one had used conventional materials such as sand-cement blocks.

(v) Residential Houses at Kingoruwira, Morogoro Municipality

This case refers to a private residential house built in 2011 in Kingorowira in Morogoro Municipality. According to the interviews with the owner of the house, local masons were engaged to construct the building but with technical support from NHBRA. In this project, NHBRA provided the inter-locking bricks press (IBPM) machine as well as supervised the artisans during the construction. Physical inspection of the house revealed that it was in excellent physical condition, without any sign of destruction or cracks formation. Besides, like most other houses noted elsewhere during the fieldwork studies, the structure also looks very attractive. The owner also asserted that he had made substantial saving because he used IMB machine technology and soil-cement bricks. He added that his neighbours also admired his house for its aesthetic quality. The cost of the house was also reported to be affordable.

Regarding possibilities to upscale the use of the NHBRA materials and technologies, the respondent noted that, in most cases, the soils are quite suitable. In fact, many houses in the municipality are increasingly being built of either sun-dried or burnt bricks walling suggesting that the NHBRA materials and technologies used in the building can easily be adopted.

Plate 6.5: Residential Houses in Kingoruwira, Morogoro

Source: Fieldwork, April 2014

(vi) Kibaigwa Milling House in Dodoma Municipality

The Kibaigwa Milling House is an old building constructed using NHBRA materials and technologies. The inter-locking soil cement bricks building, which houses a milling machine, was erected in 2008 and is a private property which was built by local artisans who were trained by NHBRA.

Plate 6.6: The milling machine house at Kibaigwa

Source: Fieldwork, April 2014

According to the owner of the building the use of NHBRA technology and material has proved to be quite good. He added that despite intensive use of the building and persistent vibrations, the structure remain intact and had shown no sign of deterioration or cracks. Owing to the good performance and relatively lower cost of the materials and technologies, one of the conventional bricks producers in the area has borrowed the old machine, and is now producing inter-locking soil-cement bricks for sale.

(vii) Interlocking Bricks and Fibre Reinforced Concrete - Demonstration House Mafia District

In 2003, NHBRA carried out two projects in Mafia District to disseminate and publicize the use of NHBRA soil-cement bricks and interlocking bricks and fibre reinforced concrete tiles. Local leadership at the District and Ward levels considered the NHBRA materials and technologies as panacea to the high cost of conventional building materials in the island. They, however, are disappointed that the project had not targeted the right group or individuals who would have sustained and spread the knowledge. They also argued that lack of adoption of the technology in housing projects on the island is a result of poor demonstration projects (i.e. unrealistically small or inconspicuous demonstration house), coupled with lack of technical support from NHBRA.

During the last five years only two individuals and Kitomondo Secondary Schools have sought to use the interlocking bricks. Respondents urged government to take a lead in adopting the technology as a means of convincing the private individuals on the efficacy of the materials and technologies. Acceptance of the materials and technologies was reported to be very high when the technology was first introduced but had waned over time; primarily, because of low visibility and use (by the public sector) of the materials in the district.

Plate 6.7 Inconspicuous demonstration house at Kiengagani Office, Mafia

Source: Fieldwork, April 2014

6.3 Emerging Issues

1. NHBRA raw materials are abundantly available in the country; however, the products are not readily available, even in Dar es Salaam where NHBRA is located;
2. NHBRA materials and technologies are regarded as affordable,
3. So far there are no formal standards, building codes and regulations regarding the NHBRA products.
4. There is no technical support to support further the use of NHBRA materials and technologies, and also resources to disseminate the materials and technologies are inadequate.

Chapter Seven

Relevancy and Impact of Research by NHBRA on Housing

7.1 Introduction

Among the main causes of the housing inadequacies in Tanzania is rapid urbanization, high prices of the conventional building materials and technologies. NHBRA research activities in housing and particularly in affordable building materials and technologies are therefore necessary to reduce the cost of house construction. The ultimate objective is to facilitate prospective home builders to easily access building materials and technologies that are of high quality and affordability and thus facilitate the construction of good houses at the lowest possible cost.

The research areas which NHBRA have focused on, since its inception include:

(i) Stabilized sand with cement bricks/blocks for foundation floors, wall and roof;
(ii) Stabilized soil with bricks and blocks for foundation floors, wall and roofs;
(iii) Fiber reinforced cement (FRC) tiles for roof and floors;
(iv) Burning bricks by using agricultural waste i.e. husks from rice coffee etc. and other by-products like saw dust and the like;
(v) Improved kilns for lime production (reduce fuel consumption);
(vi) Formwork for ring beam or lintels construction;
(vii) Use of natural or artificial pozzolana to reduce cement in the construction of wall;
(viii) Interlocking bricks press machine (IBPM) for production of interlock bricks (IB);
(ix) Vibrating machines and moulds for production of sisal reinforced concrete tiles (FRC tiles),and;
(x) Concrete desk as appropriate primary school furniture.

NHBRA has also carried out research on the occurrence of affordable building materials in the country. Appendix 7 shows the availability of materials identified in the country. The results from these research activities have been and are still used in house construction activities in the country. In the course of undertaking this assignment, various materials and technologies innovated by NHBRA were identified and assessment made with regard to their quality and quantity. As noted earlier, their use remains limited. The main outputs from research activities that were carried out between the 1970s and 1980s include research reports, working papers, maps availability of building materials in Tanzania and the preparation of data sheets for building materials and technologies information.

7.2 Impact of NHBRA Research and Technologies on Housing

The national construction industry policy (2003) aims at monitoring application of cost effective and innovative technologies and practices to support socio-economic development activities such as shelter and infrastructure delivery. The policy also emphasizes income generation activities, technologies and products which are not harmful to the environment and human health.

The operations and activities undertaken by NHBRA to develop five cost effective and affordable technologies that can be used to improve housing delivery schemes in various parts of the country directly contribute to the implementation of the provisions in the National Construction Policy. These technologies include interlocking brick press machines, cinva-ram block press machines, roof tiles making vibrators, roof tiles moulds and moulds for building blocks and bricks.

Apart from these technologies, NHBRA has also assisted in improving kilns for burning bricks in the country, as well as improvement of VIP latrines in schools. The adoption of the NHBRA technologies has led into increased utilization of the locally available materials such as clay soil into the production of burnt bricks, interlocking soil cement bricks for house construction in many parts of the country. This includes low income housing schemes in Chamazi, Dar es Salaam; Sejeseje in Miyuji, Dodoma Municipality; in Tarime, Mara Region; a housing project in Mnkunkwa Village in Biharamulo District and Ruangwa District in Lindi, Region.

One of the main factors that have hindered the wider impact in terms of use of NHBRA materials and technologies is poor visibility in villages, districts and urban centres. Besides, there is no large scale production of the NHBRA building materials and technologies. Failure to mobilise and closely work with the private sector is also a handicap.

Despite, these shortcomings, several impacts have emerged from the use of the NHBRA building materials and technologies. The main impacts of research activities undertaken by NHBRA on building materials and technologies can be categorized under four themes, namely; socio-cultural impacts, economic impacts, environmental impacts, as well as those impacts which relate to specific policy reforms or action. Owing to lack of quantitative data that relate to the specific impact areas, qualitative attributes that indicate existing and potential impacts of the research are outlined. The impact of the building materials and technologies innovated are summarized in Table 7.1.

Table 7.1: Summary of impacts of NHBRA materials and technologies on housing

Impact **Material**	**Socio-cultural Impact**	**Economic Impact**	**Environmental Impact**	**Policy action**
Soil stabilized cement blocks/bricks	• Community learnt from demonstration effects • Changed traditional houses to improved • Increased quality of life (better housing)	• Affordable cost houses (40% lower than conventional houses),by poor (about TShs. 3-5 million) • Increased employment and income generation opportunity especially for low income	• Enhanced environmental conservation • Relatively low water consumption technology • Enhanced value of local building materials	• Re-ignited policy debates on affordable houses for the poor ~ (TShs. 3-5 million), i.e. to USD Vs 25-30 million for conventional houses and technologies

	• Opportunity for enhanced changes in mind set viz the urban poor cannot access own houses	households (especially women). • Increased opportunity for competition in the construction industry • Enhanced potential to increase capital formation		• Increased spin off effects– i.e. use of labour intensive use in housing NHC/VETA • Trigger the policy debates and reforms
Interlocking bricks **(SSIB)** **Inter-locking press machines (IBM)**	• Increased participation of low income in housing (incl. large self help inputs) in housing delivery (Chamazi in DSM and & Sejeseje in Dodoma)	• Enhanced efficiency in the production of building materials (SSIB/SSCB) • Attraction of microfinance programmes • Enhanced formation of social groups (Federation groups) • Promoting saving culture		
Fibre Reinforced Concrete Tiles (FRC/SFC) FRC machines testing	"	• Increased backward and forward linkages between agriculture and construction industry/housing delivery • Extended performance of the building • Improved houses	Increased potential for sisal fibre market	
Pozzolana/ **Pozzolime**	"	• Emergence of small scale industries/suppliers of pozzolana/pozzolime to i.e. Mbeya Cement Factory		
The NHBRA Study and mapping of occurrence of building materials in the country	High potentials for improvisation of indigenous technologies	• Enhanced potentials to reduce transport cost in low income housing projects. • Potential for saving foreign currency (import of building materials)	Increased potential for enhanced environmental conservation	Enhanced potential emergence of import substitution industries

Source: Fieldwork, April, 2014

7.3 Cross Cutting Impact of NHBRA Materials

Apart from the impacts outlined in Table 7.1, other cross-cutting impacts emanating from the research undertaken by NHBRA include:

- Enhanced public health; This aspect relates to improvements done in low income informal housing, especially with regards to improved sanitation systems using trapezoidal soil cement stabilized bricks;
- Enhanced institutional linkages/networks and synergies; This refers to the production of building materials, technologies and housing delivery;(i.e. emerging collaboration between NHC, VETA- NHBRA, NHBRA – CCI and Central Material Labortatory under the Ministry of Works.
- Enhanced empowerment of the poor (women) living in slums; This, refers to hundreds of women who were trained and have acquired artisanal skills in Dodoma and Dar es Salaam low income housing projects. This has improved the incomes and general well-being of the beneficiaries; and
- Apart from these positive impacts, one of the negative impacts resulting from extensive digging of soil used as raw materials is adverse impacts on environment; such as including environmental degradation resulting from open pits and soil erosion, especially in areas where materials such as sand, clay, soils or pozzolana/pozzolime have been extracted.

7.4 NHBRA Materials Testing Laboratory

The NHBRA materials testing laboratory located at the NHBRA headquarters in Mwenge Kinondoni municipality, is the main facility used to test various building materials. For heavy and large components that have to be tested, NHBRA normally uses the COET laboratory at UDSM. The tests undertaken include crushing strength and bearing strength.

Other tests performed by NHBRA laboratory are;

(i) Soil tests for engineering design purposes - density, etc.
(ii) Timber - strength capacity and, moisture absorption
(iii) Steel - strength capacity
(iv) Interlocking bricks - strength
(v) FRC tiles – strength and water absorption
(vi) Sand cement blocks - strength
(vii) Steel - strength
(viii) IBPM and FRC machines testing - Production capacity, flexibility, size and dimensions accuracy, finishing.

7.5 Emerging issues

1. NHBRA materials and technologies have had several social, cultural, economic and environmental impacts; such impacts are generally limited.
2. The key impacts, include improved access to housing by the poor; enhanced income and employment generation among the marginalized; promotion of saving culture; and increased opportunities for policy debates and reforms.
3. Environmental impacts associated with land degradation in areas where building materials are being extracted.

Chapter Eight

NHBRA Information Documentation System

8.1 Introduction

Among the key objectives of NHBRA is to ensure that research results, technical information and products related to affordable and durable local building materials; and appropriate housing technologies are made available to potential users including researchers and non-researchers. At the centre of research activities is the requirement that NHBRA has to collect, organise, disseminate and manage the research documentation in a manner that is easily accessible to end-users. Indeed a robust documentation system is a critical sector of any research institution.

The current system, including the organisation, storage and display of documented research is manual. Its output comprises among other things, an annotated bibliography of all the research that NHBRA conducted until 1999; printed paper lists of publications and books which are stored in word processed format. Documents are stored and displayed in shelves and cupboards and the referencing, retrieval and dissemination is done physically. Most of the day-to-day operations concerning information documentation is manual; except in cases where information on research studies and few other NHBRA activities have been processed digitally using word processors.

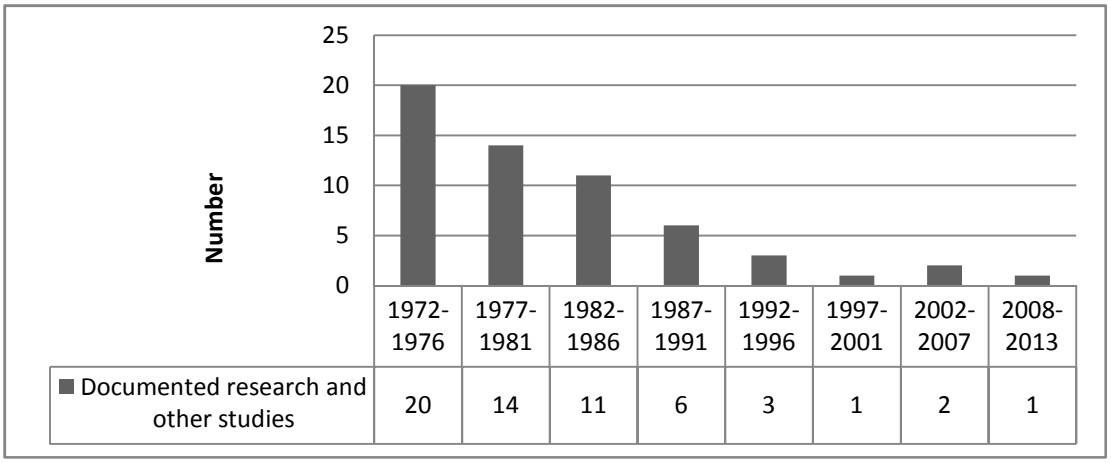
8.2 The Existing Information Documentation System

A documentation information system is an essential part of any research institution that captures, transmits, stores, retrieves, manipulates and displays documentation for processing or reading. Its components including the physical space where the information (outputs of the system) is accommodated and facilities attached to it are equally important.

Until very recently, research information was largely recorded as text in documents. Increasingly information is being represented by images, audio, video and still photographs. In addition, documents that were in the past stored in hard-copies i.e. paper form can now be digitally created stored and displayed.

Over the last 40 years, NHBRA has accumulated a great deal of information related to its functions. Most of the information is in printed text and photographic (visual) form and is stored in the NHBRA library. Very little of the information has been transformed into digital form. The documentation has declined partly because very little research work is undertaken also collection from other sources is very limited (Figure 8.1).

Figure 8.1: Documented research and other studies at NHBRA (1972-2013)



Source: Kimati and Mazanda (1999): An annotated bibliography of the Building Research Unit Publications and field interviews March 2014.

The following sections describe in detail the existing situation of documentation information system at NHBRA.

8.2.1 Document Formats

As reported earlier, NHBRA has accumulated information on building materials, technology, and human settlements geared at providing technical advice and innovations; and promoting appropriate building materials, techniques and technologies for low cost housing development. The annotated bibliography of the NHBRA publications compiled in 1999 indicates that between 1972 (when NHBRA produced its first research report) and 1999 about 55 research and technical reports were documented and accessible at the library (Figure 8.1). The information broadly covers; research and innovation; support materials for the application and use of the technologies; and support for the production, replication of building materials and technology. The information in the library is mainly in the form of print with very little non-print material. According to library staff, there are about 1000 volumes of research, books and other published material.

Print Material

The main documents in print format observed in the library include reference books, research reports, working reports/papers, data sheets and technical manuals. The documents serve different purposes such as providing information on technical data; engineering drawings, technical guidelines on machine use to mention but a few. Table 8.1 shows a sample of documents and the type of documents and general use.

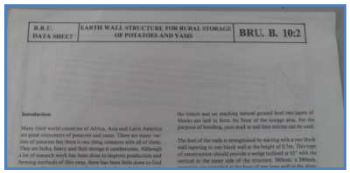
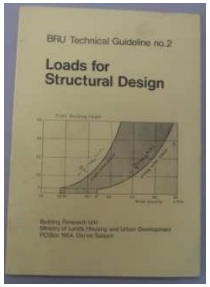
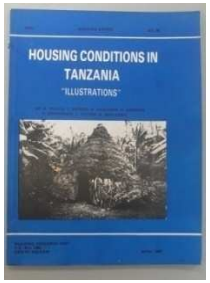
Digital (non-print) documents

As noted earlier most of the information is in print form, there is hardly any information in audio-visual form. Some recent reports on building demonstrations, sensitisation seminars and training have been processed digitally and are available on CD-ROMS. There is also some information in the form of architectural models of low cost houses, pictures and posters.

On-line documents

Although NHBRA staff has published and presented papers in various conferences and workshops, very little information is available on-line. NHBRA recently up-loaded its website but it does not have much information. What is currently on the website includes information on the roles and functions of NHBRA. Information related to the institution's research activities has not been uploaded but can somewhat be found scattered on other websites and can be accessed using search engines such as Google. The search engine using NHBRA as a key word resulted in about 42,300 results (web pages with the word NHBRA) very little was related to the research done at the Agency. Most of the reported information by other websites (government websites) was general and concern activities of NHBRA related to affordable housing development.

Table 8.1: A sample of document types at NHBRA

	Information documents	**Format and quantity**	**Purpose/contents**
1	Data sheets 	Print About 30 copies stored in the library	Show how products are made/manufactured, use technical language and are suitable for professionals such as laboratory technicians, academics, building contractors etc. Originally produced to disseminate research results to government departments, institutions, colleges and universities
2	Technical guidelines/pamphlets 	Print and pictures Quantity was not available	Show how products are made e.g. interlocking blocks – also suitable for non-professional with basic construction knowledge and relevant technical illustrations.
5	Working reports 	Print and digital About 75 reports	Research and consultancy reports undertaken by NHBRA staff - suitable for researchers and the general public interested in building materials, technology and housing construction etc.
6.	Seminar/training reports	Print and digital	Documents the process of training and demonstrations on M&T

		Quantity not available	done by NHBRA in the various regions.
7	Brochures and leaflets, newsletters	Print and digital Quantity not available	Used for the dissemination of NHBRA activities, description of materials and their use e.g. interlocking-bricks; or simple technical guidelines mainly for public use.
8	Models	Visual 3 models	Used to visually represent the M & T e.g. interlocking brick wall.

8.2.2 Document Organisation, Storage and Library Space

Organisation and storage

The common means observed for storing and displaying documents is shelves or cupboards. All the books, reports, journals etc; at the NHBRA library are kept on shelves. Due to limited space, some of the reports are stacked (haphazardly) in the librarian's office (Plate 8.1). The lack of a systematic storage system makes it very difficult for users to access books or retrieve information. It was also observed that books and other print materials were not arranged according to subjects thus making it difficult to locate books or reports. There is no cataloguing or classification of reference materials. A similar observation was made in 2005 by a consultant who undertook a study on the NHBRA library whereby it was reported that *"...the collection available at NHBRA is not well-organised...the building resembles a run-down book store"*. Nine years later there seems to be very little improvement. Furthermore, the search for material and information is made difficult because indexing and cataloguing arrangements do not exist. Fragile print-materials such as posters and pictures were also observed to be stored in a haphazard manner thus exposing them to damage by dust, moisture etc.

Plate 8.1: Storage situation at NHBRA Information centre

Source: NHBRA, April, 2014 centre

Library space

Research documents and their preservation require much space that is systematically organized. Although NHBRA is fairly old and well established research institution, its library space is highly restrained in terms of physical space (seating and office space) and supporting facilities Plate 8.2). The library building has two rooms and the total space is about 92 square meters and is located within NHBRA complex at Mwenge, Dar es Salaam. Apart from the lack of systematic organization of the documents available, the library facility is hardly visible to a would-be user. The larger room accommodates shelves and spaces for reading while the smaller room comprises the office space for the librarian. The reading room has two medium sized tables and six chairs; and is congested as such there is hardly any circulation space particularly if one was to search for books while others are sitting and reading. Most of the research staff read from their offices and

only use the library to seek information; this happens rather rarely since much of the information is generally outdated. In discussions with the librarian on how frequently their staff visit the library; he noted that many staff visit the library to read newspapers kept centrally at the library and not often to search for reference material.

Plate 8.2: Library and office space at NHBRA

Source: NHNRA, April, 2014

Although there is an increase in digital information networks, including access to ICT and World Wide Web, the current facilities and physical space for information and documentation services at NHBRA leave a lot to be desired. In many research institutions there is a decline in library use/visits because of the rapid development of digital information that is easily accessible by users from their desktops, laptops, tablets and even cell-phones. However, one cannot underestimate the importance of an up-to-date library facility that has adequate space, systematic documentation and adequate seating facilities; basic reference material and most importantly equipped with a modern database for easy access and retrieval.

8.2.3 Information Documentation and Retrieval

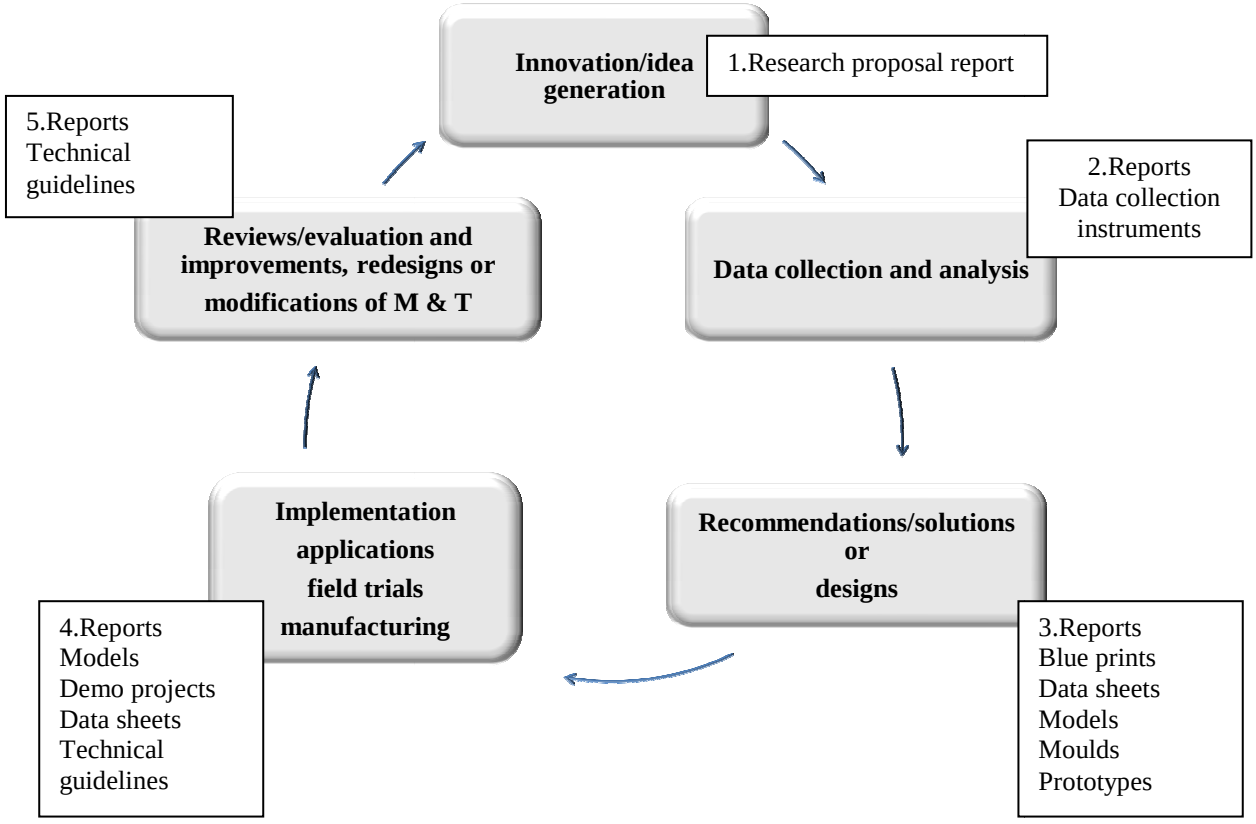
A lot of relevant research documents related to affordable building materials and technology were produced up until the 1990s. This includes studies on the *Housing conditions in Tanzania* (BRU Working Report No. 60 of 1987 and BRU Working Report No. 68 of 1990) - which was documented in the form of photographs and illustrations respectively. Other key documents include the *Compilation of raw materials occurrences* and their suitability for building material purposes (BRU Working report No. 8 of 1975).

The annotated bibliography of NHBRA research prepared in 1999 has unfortunately not been updated. Researchers at NHBRA acknowledged that an effective documentation system of research knowledge is critical to scientific activity especially when the activity involves the design and innovation of new technology and products. However, as noted, the existing system was far from serving the purpose. For example, while NHBRA claims to have been the pioneers of sand-cement blocks for walling; there is however, no documentation to support this. Keeping written, visual and sometimes video documentation about the research is important especially if

the research is related to innovation, design, manufacturing and modification; replication and technology transfer such as that of inter-locking bricks or FRCs. This is critical factor for one to claim property rights on his or her works. Documentation of inventions is moreover important especially if a research institution is to apply for a patent because "research and development activities that give rise to inventions must be thoroughly documented in order to successfully manage patents" (Crowell, 2007:773).

In the course of the research/innovation process, NHBRA produces relevant documents to reflect each stage (see Figure 8.2). NHBRA has documented more or less each of the projects that it has been involved in. This is in form of photographs and printed documents however as noted earlier these are not indexed. In some projects, NHBRA has produced fliers, brochures, datasheets, technical guidelines and manuals. NHBRA officials maintained that it normally leaves behind technical manual in areas it has been involved in project implementation.

Figure 8.2: A typical NHBRA research documentation process and key outputs



Source: Fieldwork, April, 2014

One of the most popular documents available at the library is the leaflet on soil testing by sedimentation named, *The Bottle Test.* This includes simple instructions in Kiswahili that have been produced in printed form, and is comprehensible to many users.

Interview with various staff at NHBRA revealed that there has been no physical artefacts that have been preserved. For example the first designed and manufactured interlocking brick and other similar inventions have been neglected, damaged and later thrown away because they appeared like waste. There is, therefore, no depository/archive or a small scale technology museum that would otherwise accommodate preservation of classic technological innovations for users to learn from.

8.2.4 Other Documentation Processes

Project record keeping and documentation

During the fieldwork interviews at NHBRA it was revealed that while documentation on the projects undertaken was at times not available in the form of retrievable reports; the information was available in administrative files of the Agency (paper-base records). The files record and document information and data on training, demonstration, construction and research processes and outputs. The information in files includes the geographic areas where specific NHBRA staff or teams are travelling to; team composition, budgeting, time frames of the activity to be discharged and so on. Commensurate with procedures in the public service the files are indexed and managed by the NHBRA central register. Interviews with various NHBRA staff indicated that sometimes reports on training, demonstration or research activities may not be kept in the library but the information can be found in the administrative files. As can be expected, some of these files are too old and cannot be accessed.

Regarding researches done and documented by NHBRA in the past, it appears that there is lack of a mechanism to systematically update studies to match new developments. For example, studies carried out on the use of different kinds of binders to reduce cement content in bricks or the use of agricultural and industrial waste for building purposes could have been further researched on or modified for adoption and use. In addition, indigenous knowledge on building materials and practices has been documented by NHBRA but the information is not readily accessible for reference. As such, researchers do not have a solid base to embark on further studies on the same materials.

There is also lack of an inventory of innovation and technologies for example, those certified by the Tanzania Bureau of Standards (TBS) or even those that meet ISO standards. Such a repository of material specifications/standards in print form, such as leaflets, brochures would be valuable reference material to prospective clients of NHBRA such as building designers, architects and quantity surveyors.

8.2.5 Management, Personnel and Equipment

Persons with the requisite qualifications and skills are critical for an information documentation system to work efficiently and effectively; primarily because such a system would not only comprise the traditional functions of a library/documentation centre but would also involve staff

who can support researchers by providing them with the efficient ways of documenting, disseminating as well as searching for information. Currently at NHBRA there is only one staff managing the information centre. He is not a professional librarian but has accumulated valuable experience and knowledge on NHBRA research documents and therefore assists greatly in the documentation and dissemination of M & T knowledge. Lack of a professional librarian means that research products including documents (books, reports, journals etc) are not adequately or properly managed.

Equipments

The library has one desk-top computer (which was not working at the time of interviews), a small photocopier and one spiral binder equipment which assist the librarian to prepare documents such as safari reports, seminar reports as well as documents for board meetings. Lack of dedicated equipment for reproduction services such as a heavy duty photocopier, scanner and printer makes it difficult for the staff managing the library to produce copies of research reports for storage and reference thus limiting dissemination activities. Most staff have their own desk-top or laptop computers which they use to document routine activities including preparation of reports. NHBRA does not have an information documentation policy nor does it have a library policy. A Research Agenda (2013-2014) which among other things, recognises *"a research strategy which is feasible necessitates a need for access to facilities essential for publication and useful documentation retrieval means"*. However the Agenda has not yet been operationalised. An information documentation policy would among other things require researchers to deposit their works in the library, feed into the existing information documentation systems and provide feedback to future research works.

8.2.6 Users of NHBRA Information Documentation System

According to interviews with staff at the library, the user population of NHBRA technology or building materials information include; individual home builders; large and small business enterprises involved in building material technology; large private and public sector builders; academic and non-academic research institutions; and policy-makers and decision makers. Table 8.2 illustrates the type information most users sought. However, there was no record available on the quantity sourced.

Table 8.2: User and type of information sourced/searched at NHBRA Library

	User	**Type of information sourced (on materials and technology)**	**Remarks**
1	Individual home builders	Guidelines on soil tests. General information on interlocking bricks.	Occasionally Would prefer information that is easy to read
2	NGOs e.g. WAT, CCI	Training and manufacturing instructions	Occasionally

	including housing cooperatives	on interlocking brick and FRC technologies.	
3	Large and small business enterprises (contractors, manufactures and suppliers)	Guidelines on soil tests. General information on interlocking bricks and FRC technologies. Other reports on construction subject.	Regularly, would prefer documents with illustrations.
4	Large private and public sector builders e.g. NHC, LUAs, private real estate	Information on NHBRA materials and technologies.	Occasionally, would prefer documents with illustrations.
5	Academic and non-academic research institutions e.g. Ardhi University and University of Dar es Salaam	Research reports on NHBRA materials and technologies.	Occasionally, would prefer both illustrated and plain/non-illustrated documents.

Source: Field visits and interviews, 2014

Visitations to the library are generally few and have dwindled over the years. In 2005 the estimated clientele were about 1,000 per year i.e. about 3 visitors a day. At present, it is estimated to be 3 visitors a week. There was no data was available on the types of information sought or quantity. During the 4 days of fieldwork interviews, the team did not observe any inquiries for information at the library. It was also observed that the library was closed for some time when the only staff was on leave. Follow-up on this revealed that there was lack of competent staff to manage the library during such occasions. On probing further it was revealed that there was not much inconveniences or service related consequences when the library is closed, suggesting that the NHBRA library is rarely used by staff. It was also revealed during interviews with NHBRA staff that since research activities have come to a standstill, no new information is generated and as a result most of the available reference materials are obsolete.

8.2.7 Collaboration with other institutions and areas of collaboration

Overall there is weak collaboration with peer institutions in terms of information exchange. Training and demonstration activities compel both NHBRA and the beneficiary institutions to collaborate and exchange relevant reports on materials and technology. This refers to for instance, the collaboration between NHBRA and CCI or WAT on constructing affordable housing. However very rarely is information exchange sustained beyond the specific project areas; unless NHBRA is called upon to backstop or provides technical advice on specific issues.

Although NHBRA has had links with international institutions including peer institutions in Scandinavian countries, presently, no significant international cooperation exists. Furthermore there is no database (mailing list) or e-mail alerts that would foster connection with potential international partners in terms of information exchange.

Table 8.3: Collaboration with other institutions and areas of collaboration

	Institution	**Areas of collaboration**	**Remarks**
1	University of Dar es salaam	Research	Occasionally students seek for M&T information
2	Ardhi University	Research	Occasionally students seek for M&T information and use of material laboratory facilities
3	National Construction Council	Information exchange on M&T	Regularly
4	Tanzania Library Services	Information exchange on M&T	Occasionally
5	CCI	Training and demonstration	Occasionally as part of CCI low-income housing project activities
6	WAT-HST	Training and demonstration	Rarely, part of housing improvement projects.
7	VETA	Training and demonstration	Regularly to seek information on M & T training.

Source: Fieldwork interviews at NHBRA, April 2014

8.3 NHBRA Information Documentation System: Adequacy and capacity

Having discussed the existing information documentation system, documentation processes end-users and links with other institutions. Table 8.4 assesses the adequacies and capacities of the system and implications.

Table 8.4: NHBRA Information Documentation System: Adequacy and Capacity

Information documentation activities		Adequacy and capacity		
		Techniques	**Personnel/equipment**	**Implications**
	Documents (print, non-print and on-line)	• Documents in paper/print form are outdated and poorly kept. • No new acquisition of books etc • Little effort to acquire new M&T information from outside NHBRA	• In adequate research capacity and little engagement in research related activities hence no outputs.	• Dwindling research documentation and innovations on M & T. • Poor collection and coverage of M&T documentation (national and international)
	Research information documentation, retrieval and dissemination	• Information related to NHBRA scattered on the internet/web. • No common repository or website with links to on-line research material by NHBRA. • No physical documentation space e.g. exhibition room to support this innovation • No information documentation policy	• In adequate research capacity and little engagement in research related activities hence no outputs. • Poor IT facilities. • Link to NHBRA webpage not active.	• Poor visibility of research outputs to would be readers and users • Library services poor and not effectively used by potential users. • Old information and users not informed about new developments on M&T. • Provide content in a format suitable for quick and easy comprehension by the user. • Limited use of library (possibility of accessing information electronically exists). • Lack of information exchange platform for feedback between

				NHBRA and users of its technology and materials.
	Project record keeping and documentation	Not all consultancy project reports are accessible;	Inadequate record keeping infrastructure e.g. IT	• Information from field not swiftly transformed into digital and printed form for potential users to access.
	Organisation, storage and space	Limited space for storage and circulation Reports are stacked haphazardly. Lack of a systematic storage system makes it very difficult for users of the library to access the materials available swiftly Information is not stored or organised systematically Documentation space is limited in terms of collection space, seating and office space. Library not so visible to potential visitors.	Lack of qualified librarian Lack of computers and other digital equipments Limited digital preservation of documents	• Lack of a professional librarian means that; books, reports, journals etc are not systematically organized according to subjects and fields (indexing and cataloguing). • Fragile print-materials such as posters and pictures poorly kept. • Inadequate capacity of the documentation centre to support information needs of various users.

	Collaboration with other institutions and areas of collaboration	Inadequate collaboration - lack of techniques outreach services, information exchange with peer institutions, research and innovations collaboration networks. Poor links with the public and private sector	Lack of IT infrastructure Lack of zonal/ regional branches or focal points in the districts	• Poor visibility and link with other researchers and users of M & T (public and private sectors). • Lack of synergies with peer institutions including those engaged in affordable housing solutions e.g. WAT-HST resource centre has little or no link with NHBRA information/documentation system. • MLHHSD has information on NHBRA which is rarely sourced.

8.4 Comparative Best Practice

A best practice would prevail at NHBRA if the information documentation system was operating in a form that would improve the performance and efficiency of the library in contributing to NHBRAs mission. But also contribute in promoting affordable housing materials and technology; and solutions. In an attempt to draw lessons for improving documentation systems at NHBRA a brief analysis of the REPOA resource centre is carried out. REPOA has a total of 32 staff who comprise: 1 professor who is the Chief Executive Officer 12 research staff (2 with PhDs) and 20 supporting staff most of whom have first and second degrees.

8.4.1 Research on Poverty Alleviation (REPOA) Resource Centre

REPOA's Resource Centre provides a wide range of materials for reference and services on issues relevant to poverty alleviation and the development of Tanzania in general. As an applied research based institution, the Resource Centre provides information that facilitates the achievements of REPOAs objectives which are to (i) Strengthen the capacity of the intellectual resource; (ii)Undertake, facilitate and encourage strategic research; and (iii) Facilitate and stimulate the utilisation of research findings.

In order to deliver quality services and meet the above objectives of REPOA, the Resource Centre is facilitated by:

- Well qualified staff, 2 librarians (at MSc and BSc levels);
- A collection of about 14,200 books, reports and journals;
- Remote library catalogue search, access to REPOA's virtual library which covers users outside Dar es Salaam;
- Sufficient library space (about 150 sq.m);
- Library and information services policy; and
- Regular research and training workshops including annual workshop to disseminate research findings and research methodology trainings.

Some of the key outputs that are documented include Poverty and Human Development Report, various policy briefs and research results and documents to facilitate informed decision-making.

The information in Table 8.5 compares the NHBRA and REPOA. Both institutions have more or less the same objectives of research (human settlements development and poverty alleviation respectively) and that of ensuring that research outputs are used to address national problems.

Table 8.5: Good practice for information documentation at REPOA vis NHBRA current practice

	Information and documentation aspects	**Current practice at NHBRA**	**Good practices/technology at REPOA**
1.	Information and documentation availability (recent viz a viz outdated)	Very limited books and references to support research functions. Outdated books, reports and publications and other references.	• Extensive print and online resources and variety of media to disseminate research information. • Regular research activities producing new material • Research collaboration on topical relevant research areas.
2.	Dissemination	Poor dissemination modes. Non- automated system	• Awareness services, selective dissemination of information through the REPOA website and email alerts, • Regular research workshops for presentation of findings including high scientific profile annual workshops • Use of social media platforms for information exchange • E-mail alerts and automatic mailing list, very active
3.	Organisation and storage	Disorganised storage and (classification and cataloguing) No systematic indexing or inventorying	• Reference materials are classified and catalogued using renown library classification systems
4.	Retrieval	Poor retrieval of information	• Automated/digital retrieval systems , online databases and catalogue search, audio-visual

			section etc • Well-organized research documentation and preservation system • Existence of a virtual library to promote outreach services and remote access
5.	Library space	Library space limited and not used effectively to further NHBRAs mission. Crowded disorganised space not conducive to reading or information search.	• Sufficient library/reading space complemented by online information documentation services. Extensive use of REPOAs website. • Aesthetically pleasant reading space (little or no distractions)
6.	Staff	1 non-professional staff to oversee documentation centre	• 2 Qualified professional
7.	Equipment	1 non-operational PC used for word-processing and not library automation services. No PCs access for readers/library visitors	• Availability of ICT services to support information documentation; computers and reprographic services as well as users search for information.
8.	Information services	Limited information services and therefore no diversification to capture varying end-users	• Diversification of information services also include coordination of training on information search and research methodology stimulating research activities and documentation.

S*ource: Fieldwork, 2014*

Whilst it is acknowledged that REPOA has opportunities even by modest measure or indicators the current HBRA library does not befit or effectively support the functions and mandates with regard to research documentation and dissemination. Documentation is in fact one of the weakest areas in the product innovation, documentation and dissemination chain.

8.5 Emerging issues

1. Inadequate funding coupled with low priority and value given to information services.
2. Current research and innovation information is outdated. There is hardly new research to feed back into the library information management systems and no information to feed into research.
3. No dedicated classification and digital systems to facilitate efficient access to and dissemination of M&T research and product information particularly in the face of decline in physical visits to libraries by researchers who can remotely access information.
4. Poor visibility of the documentation centre and no strong national identity with reference to building material and technology subject.
5. Low utilisation of the documentation centre, no marketing promotion of information services at NHBRA.
6. Small library space and no reproduction centre and therefore limited information capacity.
7. Inadequate ICT staff.
8. No outreach information services and systems; therefore weak links with the end users and seekers of affordable housing solutions in the districts and regions.
9. Steady decline in research activities and publishing and increased engagement in consultancy and production with no systematic documentation of outputs.
10. Little efforts to collaborate and network with other institutions;
11. .Lack of an Information documentation policy.

Chapter Nine

Dissemination of NHBRA Products

9.1 Introduction

This chapter reviews the promotion of building materials and technologies innovated by NHBRA. Promotion as used here refers to making the information about a specific product known to users or consumers using different dissemination modes. Three dissemination modes adopted by NHBRA to make the innovated building materials and technologies known to the producers and consumers are presented. The modes include awareness creation; sensitization seminars and practical training; workshops and technical forums. The chapter also presents the marketing and resources capacity, adequacy of the dissemination modes, including shortcomings as well as comparative best practices and emerging issues.

9.2 Existing Modes of Dissemination

Dissemination refers to the distribution of information or knowledge through a variety of ways to potential users or beneficiaries. It is normally a two way communication process that involves the understanding of the concepts and possible implementation of changes as intended results of the dissemination activities. Dissemination modes include electronic and print media, (written information), and person-to-person contact. These are modes that have been adopted by NHBRA in disseminating information on building materials and technologies.

(i) Public awareness creation

The dissemination modes for NHBRA are included in the annual activity plans and in the annual budget for the agency. In each financial year, the agency prepares plans on the modes for the dissemination of building materials and technologies in different parts of the country. The main modes of dissemination constitute (i) awareness creation (ii) sensitization and practical training (iii) workshop and technical forums. The main dissemination modes are detailed in the ensuing section.

Media for dissemination

In order to facilitate the promotion and visibility of the NHBRA materials and technologies, the agency uses public awareness creation media that include the electronic media such as website, radio and TV programmes, print media that is newspapers, data sheets and technical manuals. Exhibitions are also used to provide details on the availability of technologies for walling and roofing materials developed by NHBRA. Through various means of awareness creation, the would be users are informed about the NHBRA technologies, building materials such as soil-sand-cement bricks; soil-sand-cement interlocking bricks; soil- sand- lime-bricks; and sisal-fibre cement roofing tiles.

Website and CD ROMS

NHBRA has a website that it could use to disseminate information on both building materials and technologies. However, it is not developed nor does it have the relevant information. It contains very little information on building materials and technologies. Moreover, the agency has also produced few CD ROMs demonstrating various building materials and technologies. Their distribution outlets are limited to NHBRA headquarters.

In addition, scholarly publications by NHBRA staff members are not uploaded on the website. This limits the dissemination and overall visibility of the NHBRA. This is an issue which also is associated with the inadequacies of the documentation as pointed out in Chapter eight.

Although there is one staff who is an ICT expert, the problem of dysfunctioning website continues. At the same time it is not possible to fully utilize the skills of staff because of lack of working equipment and research outputs. Thus, potentials to use the website to disseminate the limited information on NHBRA, products have not been tapped.

Radio and TV programmes

TVs and radio programmes are also used to disseminate information on NHBRA building materials and technologies. The media popularise visual images on the nature and type of building materials produced using NHBRA technologies. The media can facilitate the information dissemination a large part of the country within a short period. In Tanzania, there are 15 million radio sets as well as 6.5 million TV sets. Most of those with TV sets are in urban areas. Overall, the use of radio and TV programmes by NHBRA in disseminating information on building materials and technologies has been quite limited. In particular, there are no regular radio and TV programmes in both public and private media outlets for disseminating information on NHBRA products. The only time radio and TV programmes are used to disseminate NHBRA information on building materials during DITF and the *Nane Nane* exhibitions. Even then the coverage on NHBRA activities is limited because on such occasions there are many public private institutions which take advantage to advertise their products.

On the other hand, radio and TV programmes are expensive. For example, it costs TShs 3-5 million to broadcast a TV advertisement for three minutes. Given the limited funds NHBRA receives from the government, the use of such media for disseminating information is quite restricted. For example, during the interviews with staff members responsible for promotion of building materials and technologies, a question was asked: *"How often in recent years has NHBRA advertised on building materials and technologies using radio or TV?"* The response tells it all: "*in the past three years there have been no TV or radio programmes broadcast on NHBRA building materials and technologies because of lack of funds"*.

Print media and leaflets

Print media that include leaflets, data sheets and technical manuals and newspapers are also used to disseminate NHBRA products. These are produced in Kiswahili and English languages so as

to reach a large section of Tanzanians. Over the past four years, NHBRA has distributed 12,500 printed materials leaflets, technical manuals and leaflets with details on building materials and technologies to those who had been trained or those who inquired on the technologies. Considering the population and geographical size of the country, the number of printed materials seems to be a drop on the ocean.

NHBRA does not use regularly local newspapers to disseminate information on its products. On the other hand, local newspapers do not reach a large section of the targeted audience. In Tanzania, the total number of issues (in all newspapers) ranges between 5,000 and 60,000 per day. In most cases households in rural areas hardly get newspapers.

Furthermore, the circulation of newspapers is 1.62 per 1,000 people in Tanzania, while in Uganda 2.53 per 1,000 people and in Kenya are 8.3 per 1,000 people. Given the large national population of over 45 million, the small circulation ratio (1.6:1,000) would suggest many Tanzanians do not have a culture of reading newspapers. In this respect, dissemination of NHBRA through local tabloids might not make significant inroads in the marketing of its products.

In addition, the regular use of print media, particularly newspapers is expensive for a non-commercial entity like NHBRA. For example, it costs between TShs.3.2 – 3.5 million per full colour page, TShs 1.6 million per half page, TShs.375, 000 and TShs.1,000,000 per quarter of a full colour page of a newspaper.

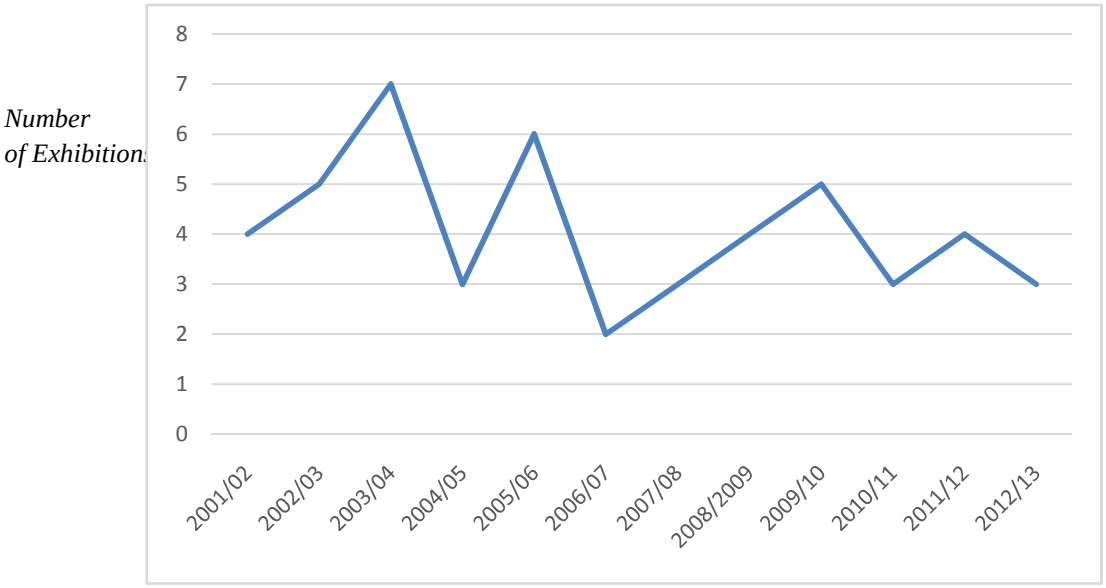
Exhibitions

Exhibitions are also used to disseminate NHBRA building materials and technologies. The target groups are individuals, private firms and public institutions. The Agency has used exhibitions as forums to disseminate information on specific technologies and products such as the press interlocking brick machine, and press brick making machines. Other technologies exhibited are tile vibrators and mould technology and manual handled machine for producing sisal cement roofing tiles. The popular exhibitions are DITF, the *Nane Nane* and the Government Ministries and Departments exhibitions. These are, however, annual events which are insufficient to reach a large section of the national population.

The interviews revealed that the Agency had stopped participating in the DITF because it had limited impact in terms of visibility, mainly because it is always held in Dar es Salaam. NHBRA has resorted to participate in the *Nane Nane* exhibitions whose venues shifts each year. The exhibitions of professional bodies that are held in Dar es Salaam provide an opportunity to reach a large audience of individuals or firms. NHBRA does not participate in exhibitions organized by international firms or private sectors such as the Turkish, Syrian or Indian exhibitions.

Figure 9.1 shows that over the years the number of exhibitions in which NHBRA has participated in has been varying, with overall decreasing trend. Such a situation not only limits the visibility of technologies in the large part of the country, but also restraints marking of its products.

Figure 9.1: Trends in NHBRA participation in exhibitions during 2001/02 -2012/13



Source: Fieldwork, April, 2014

Despite limited and declining participation, the exhibitions held so far had had an impact in terms of enhancing awareness particularly among the political leaders and private firms on the NHBRA and building materials technologies. For instance, His Excellence the President of the United Republic has bought several IBPM for support of twelve youth group in Coast region. The Prime Minister on his part had also directed District Councils to purchase the interlocking brick making machines and to form youth groups that shall be producing building materials in the Districts. The two national leaders decide to take these decisions in appreciation of the quality products produced by NHBRA.

In the period of 1997 to 2012, NHBRA produced and sold 281 interlocking bricks manual press machines to individuals and institutions that were informed and learnt about this through various media outlets. This figure is not really impressive; calculations show that NHBRA has produced an average of one machine per month. Given the low visibility of NHBRA technologies adoption may be restricted as well. The low average of one machine per month could be an indication of poor dissemination programmes and lack of marketing strategies.

This is demonstrated by the statement of an official of TBA who, during interview, said *that "I had never seen anybody from NHBRA telling me about building materials technologies and since*

I am involved in constructing government buildings, I had expected NHBRA to inform me about the materials and technologies."

It is also important to point out that, dissemination activities in media, exhibition and so on have not been supported by adequate supply of technologies and building materials. For any promotion of a product to be effective, its availability is critical. As noted in Chapter Six, low visibility or non-availability of NHBRA material and technologies is a challenge that undermines dissemination initiations. Table 9.1 shows dissemination of various building materials and technologies.

Table 9.1: Dissemination of NHBRA materials and technologies

Technology/materials	**Dissemination media**	**Existing Situation**	**Challenges**
Interlocking Bricks Manual Press Machines (IBM) Press Brick Making Machines • Manual handled machine for producing sisal cement roofing tiles • Tile vibrators • mould technology Soil-sand-cement Stabilized-interlocking blocks-Soil-sand-bricks Sisal-fibre-cement roofing tiles	NHBRA website	• The website not always active. • It is not regularly updated • It is least developed and it is contents very limited. • Limited ICT capacity in terms of infrastructure and facilitating.	• It is not effective in disseminating information to large section of the population. • Resource capacity limits the use of the website to disseminate information on NHBRA products.
	Radio and TV programmes	• There are no regular Radio and TV programmes. • Disseminate technologies • The radio and TV programme are running only during the national exhibitions such as NaneNane and DITF. • It is expensive to radio and TV programmes • The coverage for radio and TV broadcast is low, most rural areas do not access to TV/Radio.	• The potential of the radio and TV have not been fully exploited to disseminate information on NHBRA products. • Inadequate funds limit the use of radio and TV to disseminate building materials and technologies. • lack of marketing strategies limits the exploitation of synergies of various dissemination programme.
	Data sheets and Technical guidelines and manuals Newspapers, leaflets	• The coverage of newspapers and leaflets is low • Details on the newspapers and leaflets are not adequate or very informative for those	• -They reach a limited audience. • -The potential of the media is not fully used. • -Inadequate funds limit the use of print media to disseminate building materials and technologies. • Lack of marketing strategies limits the

Technology/materials	Dissemination media	Existing Situation	Challenges
		seeking NHBRA technologies/materials. • One has look/approval them. They are doing business. • Little culture of reading newspapers in Tanzania. • Advertisement in newspapers. are expensive and limited coverage.	exploitation of synergies of various dissemination programmes.
	Exhibitions e.g. DITF, NaneNane	• Each exhibition is an annual events, one cannot easily make a follow-ups once informed on NHBRA technologies. • NHBRA change venues for Nane Nane exhibitions in each year. • DITF, regulatory and professional bodies exhibition are confined to Dar es Salaam. • Competitions with other institutions that organize exhibitions for building materials. • NHBRA does not participate in the exhibitions organized by the private sector e.g. Turkish and Syrian exhibitions.	• Reaches a limited audience • The potential of the media is not fully used. • Inadequate funds limit the use of exhibitions to disseminate building materials and technologies. • Lack of marketing strategies limits the exploitation of synergies of various dissemination programmes.

Source: Fieldwork, April 2014

Sensitization seminars and practical training

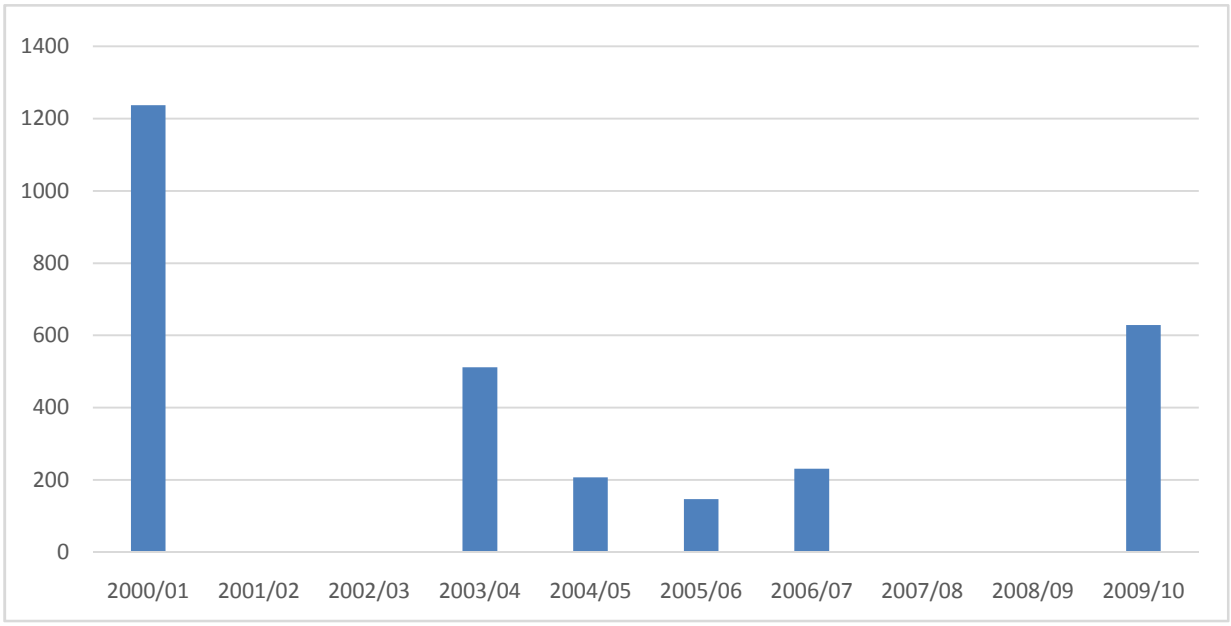
In order to inform the general public on the NHBRA technologies, the Agency has prepared manuals and training programmes on the various products, including Interlocking Bricks Manual Press Machines (IBM), Brick Pressing Machine (BPM) and Manual handled machine for producing sisal-cement-roofing tiles technologies. The target groups are mainly local authorities and public institutions. Sensitisation seminars and practical training have been conducted to impart skills are used to produce materially such as that are used to produce soil-sand-cement-stabilized blocks; soil-sand-cement inter locking bricks as well as Sisal Reinforced Concrete

Tiles (FRC) tiles. The bricks and roofing titles have been used in the construction of health centres, dormitories in secondary schools as well as residential houses in various regions in the city.

(ii) Seminars

The seminars are used to disseminate information on NHBRA technologies and products mainly to grass roots youth based building brigades in the districts. Seminars are not however, used regularly because they are demand driven. They have therefore been conducted in only a few districts. In most cases, seminars had been sponsored by either district councils or few private firms companies or CBOs and NGOs. This implies that training or sensitization using seminars depend on the availability of the funds by the sponsoring agents. They are therefore demand driven.

Figure 9.2: The number of people trained on NHBRA materials and technologies in district councils 2000/01 – 2009/10



Source: NHBRA 2014

It is also important to note that through seminars and sensitization workshops, NHBRA trained grass roots building brigades in 55 districts in the country during 1997- 2012 period. This is low number given that Tanzania has 169 districts. In addition, during the period a total of 3,002 people were trained on NHBRA materials and technologies in the district councils (Figure 9.2). On average, 198 people were trained on NHBRA technologies per annum. Given the vastness of the country and its population of over 45 million, this number is very low.

Figure 9.2 further shows that in some of the years there were sensitization seminars held. This suggests that in those years, there was no demand for seminars. That Districts and other institutions either did not have budget for the NHBRA training seminars or did not plan for them.

(iv) Practical training and demonstration sites

Seminars are normally followed by practical training. Practical training involves the production of either walling materials or both walling and roofing materials. The walling materials produced are either soil-sand stabilized cement interlocking bricks or soil-cement interlocking bricks; whilst sisal fibre cement tiles are produced for roofing.

Table 9.2: Dissemination of technologies and building materials through sensitization and practical trainings

Technology /materials	Dissemination media	Existing situation	challenges
• Interlocking bricks manual press machines (IBM) • Press brick making machines • Soil stabilized cement blocks • Soil sand cement bricks • Soil sand cement interlocking bricks • Manual handled machines for • Tile vibrators and moulds	Seminars	• Not conducted regularly • LGA, private firms CBO and NGOs sponsor the training seminars • Demand driven • Few LGA and larger firms sponsors the seminars • Training conducted in 55 districts • Few individuals participate in the seminars • Too few NHBRA staff, cannot cover a large part of the country	• Low demonstration effect realized because of focus on the peripheral areas • Little visibility of the demonstration sites • Non availability of funds and public projects limits dissemination.
	practical trainings	• Not conducted regularly • LGA, private firms CBO and NGOs sponsor the training seminars • Demand driven • Few LGA and larger firms sponsors the seminars • Training conducted in 55 districts • Few individuals participate in the seminars • Too few NHBRA staff, cannot cover a large part of the country • conducted in selected villages or towns which are in the peripheral	• Low demonstration effect realized because they are done in the peripherals • Little visibility of the demonstration sites • Availability of funds and public projects limits the dissemination of the technology

Technology /materials	Dissemination media	Existing situation	challenges
	Demonstration sites	• Facilitated/depends on the availability of public projects • Constructed in remote districts areas • Not constructed regularly • LGA, private firms CBO and NGOs sponsored the construction • Demand driven • Demonstration sites in 55 districts	• Low demonstration effect because they are done in the peripherals • Little visibility of the demonstration sites • Availability of funds and public projects limits the dissemination of the technology

Source: Fieldwork, April 2014

(iv) Workshops and technical forums

Workshops and seminars are another dissemination mode used by NHBRA. Based on research findings and practical issues concerning the NHBRA technologies, staff members prepare scientific papers which are presented at various workshops organized by regulatory or professional or academic institutions in the country. These include workshops and forums organized by AQSRB, ERB, and CRB to mention but a few. Such forums offer and enhance not only NHBRA visibility with regard to building materials and technologies, but also provide opportunities for technical expertise.

Table 9.3 shows that the workshops and technical forums provide opportunities for NHBRA to reach the would-be users and producers about its products. However, NHBRA has not been effective in using this fora because overall very few papers or research output have been produced in recent years. Interviews further revealed that the Agency does not have a Journal and Newsletters through which it could disseminate or inform the would – be users and producers of building materials about their activities. Limited research outputs, and low research capacity and culture have generally restricted the visibility and dissemination of the NHBRA materials through the use of workshops and technical forums.

Surprisingly for years, NHBRA did not have a budget item for research funding only recently NHBRA has introduced this research line item in its budget. The lack of research budget line could be attributed to the gradual decline of research capacity and culture at NHBRA.

Table 9.3: Dissemination of technologies through workshops and technical forums

Technology /materials	Dissemination through	Existing situation	Challenges
• Interlocking bricks manual press machines (IBPM) • Brick pressing machines • Soil stabilized cement blocks, • Soil stabilized cement inter locking bricks	workshops	• Some staff members participate in (few) workshops • Low research capacity and outputs • Low funding of research • Most workshops held in Dar es Salaam • the workshops may inform the large scale producers • Lack of own newsletter or journal • Published papers not uploaded on the website	• Limited opportunity to share expertise on NHBRA technologies with the users and producers • Limited visibility of NHBRA products • Little research outputs produced • Limited capacity to publish and issue newsletters regularly
• Manual handled machine for producing sisal cement roofing tiles • Tile vibrators and moulds • Sisal reinforced concrete tiles (FRC)	Technical forums	• Staff members participate only in few workshops • Low research capacity • Low research outputs (papers) • -Low funding of research funding Most workshops held in Dar es Salaam • Workshops inform the large scale producers	• Limited opportunity to share NHBRA technologies/materials • Limited visibility of NHBRA products • Limited outputs produced and disseminated

Source: Fieldwork

9.3 Marketing capacity

Marketing

Marketing entails the coordination of the three elements of identification, selection, and development of the products; determination of prices; selection of distribution channels to reach the customers as well as development of promotional strategy. Marketing also involves developing demand for a product and fulfilling customers' needs. These four aspects provide the basis for assessing the marketing of NHBRA products in the country.

Identification, selection and development of the products

In order to make its products known to the public, NHBRA has been undertaking a number of activities that constitute marketing. Specifically, NHBRA has identified and developed building materials and technologies that target a particular niche of customers, that is, the low and middle income groups in both urban and rural areas, as well as the public institutions.

In particular, NHBRA has developed technologies for soil-sand-cement bricks, soil-sand, cement, brick and sand- soil- lime bricks. It has also developed as sisal-fibre reinforced roofing tiles. As discussed in Chapter Six on the raw materials for producing building materials are generally available in different quantities and qualities in various parts of the country. In this regard, the technologies developed by NHBRA can be easily adapted or used in many regions because they can be customized to availability of materials in the different locations in the country.

Business analysis and prices

The development of building materials and technologies need to be done together with business analysis. Such an analysis allows the determination of products and their prices. Given that the technologies developed seek to promote the use of locally available low price materials, the cost of building materials and housing units constructed are as expected to be lower compared to those using conventional materials. For example, a two bedroom house constructed in Miyuji in Dodoma Municipality using NHBRA technologies (SSIB and SCRF tiles) costs TShs 3.0 – 5.0 million, while a similar building using sand-cement blocks and CIS costs TShs 32 million**.** However, many households do not know how much they save if NHBRA building materials are used instead of the conventional ones.

Not only that the saving made from the use of NHBRA materials is not known, but also the prices of the various building materials and technologies are not widely known by the general public. This limits the marketing of the NHBRA products. For example, during a field visits in Mvota Village, Biharamulo District, an individual who was asked whether he knew what the price of interlocking bricks press machines was he replied: *"I have no idea of the price of the interlocking brick press machines, although we had been provided with some machines by the African Barrick Gold Mining Company"*.

Distribution channels for reaching the customer

As pointed out in the previous chapters, NHBRA does not have branches or offices in the upcountry districts. In particular, there are no outlets for NHBRA building materials apart from the head office at Mwenge, in Dar es Salaam city. Such a setting, limits the marketing of the NHBRA materials and technologies as well. No wonder over the 1997 – 2012 period, NHBRA sold only 281 machines.

Given the absence of outlets or demonstration centres for NHBRA products in the districts, grass roots building brigades could provide important support. However, in most districts (including Bagamoyo and Biharamulo; Tarime, etc) the building brigades (such as those intended to support youth groups) are not operational, although, many received training on NHBRA products.

Promotion strategy

The promotion activities that have been undertaken by NHBRA are shown in Section 9.1. In addition, NHBRA had signed Memorandum of Understanding with some institutions which

among other things promote the Agency's products. For example, NHBRA had an agreement with African Barrick Gold Mine, through which NHBRA building materials and technologies were used to construct secondary school, teachers' houses and dispensaries in villages surrounding Tulawaka Gold mine in Biharamulo District.

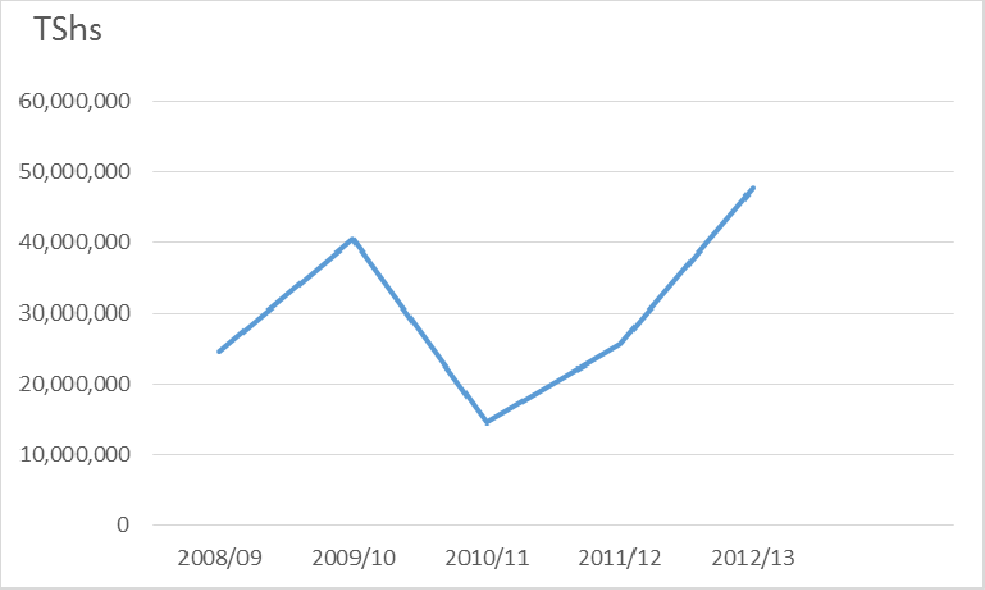
Currently, NHBRA is involved in a similar project in North Mara Gold Mine. NHC has also entered into contract with VETA to organize and train groups of youth on the production and use of NHBRA products. However, the Agency does not have a marketing plan or products promotion strategy.

Resource capacity for dissemination

Finance

At present NHBRA does not have a budget line (item) for marketing or promoting of its products[6]. However, NHBRA has been allocating some money for marketing or promotion activities. Figure 9.2 shows that the amount of funds spent on marketing NHBRA products has been fluctuating, although in the past recent years it has been rising sharply. Asked why there has been a sharp rise after 2010/11, the marketing officer noted that in recent years, there has been an increase in the costs of advertisement and fuels expenses when travelling up country.

Figure 9.2: The annual allocation of funds for marketing activities 2008/9-2012/13



Source: NHBRA, 2014

Despite the sharp rise, given the cost of advertising and other marketing options, the sum allocation is meagre and cannot effectively facilitate the marketing of NHBRA products. For instance, if one examines the costs of advertising products through newspapers, TVs and radio,

[6] One NHBRA staff informed the interviewer that NHBRA had no item in its budget for promotion and marketing of building materials and technologies.

(As shown in Section One), it is obvious that the funds are inadequate (see Section 9.1). It also ought to be noted that some of the promotion activities have been demand driven (Section 9.1). Subsequently, the coverage of dissemination activities is quite limited because it depends on priority given to NHBRA products by particularly public institutions; the latter are the main sponsors of demand-driven training workshops.

Personnel

NHBRA has one marketing officer and one ICT expert on post, whilst the establishment provides for two (2) marketing officers and two (2) ICT experts. This suggests that the Agency is understaffed in the very important functions - marketing and dissemination. This in turn undermines marketing of NHBRA products. Furthermore, since in the training of users and producers of NHBRA technologies is demand driven, coverage particularly among the low income homebuilders countrywide is small.

Equipment and facilities for disseminating and marketing NHBRA materials and technologies

NHBRA does not have adequate equipment for disseminating and marketing of NHBRA building materials and technologies. The Agency does not for instance have road show vans, audio visual facilities for demonstration of the NHBRA materials and technologies. It also has only 4 old vehicles, inadequate equipment and ICT facilities. Inadequate number of vehicles also limits the use of alternative modes for marketing and visual demonstration.

9.4 Adequacy of the Modes and Shortcomings

The various dissemination modes have focused on delivering information on NHBRA products to users, producers as well as regulators and professionals in the country. Although there are limited data to quantity the adequacy of the dissemination modes, qualitative evidence obtained during the interviews and literature review is used to fill this gap.

Adequacy of awareness creation media

The various methods used to promote NHBRA products include electronic and print media as well as exhibitions. The methods have to some extent facilitated the promotion of NHBRA products in different parts of the country. They have also informed the public on the availability of alternative building materials. For instance, a number of individuals in Dar es Salaam, Dodoma, Mvomero, Tarime and Shinyanga have adopted NHBRA building materials and technologies.

Adequacy of sensitization seminars and practical training

As part of sensitization and practical training, NHBRA has developed training manuals on: interlocking press bricks machines, press machines, and handled machines for producing roofing tiles. Such manuals have been useful in disseminating NHBRA materials and technologies because they provide elaborate explanations for practical training.

As a result of training conducted, groups and individuals both men and women as well as youth brigades have gained knowledge and skills on NHBRA technologies. This has facilitated the adoption of the materials and technologies in some communities. The latter refers to the construction of residential houses in Miyuji, Dodoma, and Chamazi, Dar e Salaam, using the available local building materials. About 3000 individuals have been trained.

Adequacy of workshops and technical forums

Through the paper presentations in workshops and technical forums, NHBRA has interacted with professionals and other potential users and producers on its products. The forums have also been used to reach regulators in the construction industry. During the last five years, NHBRA staff members have attended conferences and workshops.

Shortcomings

Several shortcomings in the current dissemination modes have been identified; these are listed under the thematic areas below:

Public awareness and sensitization seminars

i. The Agency does not have marketing plan or strategies; consequently the promotion of NHBRA building materials and technologies is done on ad hoc basis, with limited impact on the demand for products.
ii. Dissemination and promotion activities are not supported by establishment of outlets. for building materials and technologies, information on their quality and prices.
iii. The promotion activities have not adequately addressed private firms both small, medium and large scale,
iv. Inadequate resources including personnel equipment and finances limit dissemination activities.
v. Overall, current dissemination activities (i.e. use of TV, newspapers, exhibitions) have had limited impact on promotion of NHBRA materials and technologies.
vi. Dissemination and promotion of the NHBRA technologies and materials are demand driven; this strategy is no doubt important, but has also restrained coverage to all those who can fund training workshop.
vii. There is no comprehensive plan to involve both public and private stakeholders in dissemination and marketing of NHBRA products.
viii. The demonstration project sites are largely located in the peri-urban or rural (remote areas) where visibility limited.

9.4 Comparative Best Practices

Table 9.4 indicates comparative best practices in dissemination of building materials and technologies. It compares the best practices found in literature to those currently used by NHBRA.

Table 9.4: Comparative best practice for dissemination of technologies

S/No	Dissemination aspects	Current practices at NHBRA	Good practices
1	Strategies for disseminating information on building technologies	Dissemination of information on NHBRA materials is not done coherently	Involve comprehensive and robust combination of dissemination methods including written information, electronic media and person to person contact.
2	The use of languages preferred by the users	Both Kiswahili and English languages are used in disseminating information	Orientation towards the needs of the users incorporating the type and levels of information needed into the forms and language.
3	Collaboration and networking in disseminating information	Few linkages with consumers, producer and the private sector.	Draw upon and tap existing resources, relationships, networks to maximum extent possible.
4	Provision of adequate information on basic principles underlying specific practices	Limited information is provided on basic principles underlying specific practices.	Include sufficient information so that the users can determine the basic principles underlying specific practices and settings in which these practices may be used most productively.
5	Availability of outreach services	There are hardly outreach services for the innovated technologies.	Establish linkages to resources that may be needed to implement the information disseminated – usually referred to as technical assistance
6	Customer and technical support services	There are no support services to customers.	The utilization process requires time and support from the beginning to the end especially where the product are widely used.
7	Intervention is done to achieve maximum effect of dissemination	Little intervention to ensure optimal effects.	Dissemination of building materials and technologies require ongoing support and personal intervention to achieve effective utilization and adoption.

Source: Fieldwork April 2014

9.5 Emerging Issues

1. NHBRA does not have a marketing plan and strategy for dissemination of its research products.

2. Most of the current products dissemination modes have restrained coverage; consequently, many among the would be users rural in remote areas are either unaware about them or cannot access them,
3. Although NHBRA has collaborated with various institutions and actors, they have, however not exploited or tapped the potentials of the private sector and NGOs,
4. NHBRA is lacking appropriate skilled personnel for disseminating its products.

Chapter 10

Conclusions and Recommendations

10.1 Conclusions

Over the last forty years, NHBRA has operated under various central government entities as well as undergone institutional transformation that saw its evolution from a small unit of the Ministry of Lands, Housing and Human Settlements Development to a semi-autonomous Agency under the same Ministry.

The key issues emerging from the thematic areas outlined in the ToR are summarised at the end of the respective chapters. In this chapter, therefore only the main conclusion and recommendations are presented.

It has been systematically argued that despite various research activities, documentation and dissemination efforts undertaken by NHBRA over the last forty years, the impact of NHBRA in making affordable building materials and technologies accessible for low income housing remains limited. It was further observed in Chapter Three (SWOC analysis) and reflections on PESTEL (Appendix 4) that at present, weaknesses and challenges that NHBRA is facing, by far, override the strength and opportunities, limiting the Agency to deliver adequately. More specifically, it has been noted that the current institutional setting of the Agency under a government entity under the Ministry of Lands Housing and Human Settlements Development; and without much powers to make decisions does not provide a conducive institutional environment for NHBRA to efficiently operate and discharge its functions. This is *inter alia* because at present decision-making powers of the Agency are constrained. According to the interviews with NHBRA staff, the final decision on matters that concern NHBRA lies with the Permanent Secretary, Ministry of Land Housing and Human Settlements Development. The main issues that have emerged from this review are outlined below.

(i) Despite the aforementioned limitations NHBRA has and continues to play a critical role (albeit modest) in research, innovation and dissemination on non-conventional and affordable materials and technologies. Over the last five years more than ten construction projects related to affordable building materials and technologies have been undertaken. Besides, over 3,002 persons were trained between 2004/05 and 2009/10. This includes many women who were trained by NHBRA have in turn successfully implemented housing schemes in Dodoma and Morogoro.

(ii) It has been confirmed that locally available raw materials for the products innovated by NHBRA are in most cases abundantly available locally, that is, within or close to the areas where affordable homes are desperately needed.

(iii) The economics of the materials and technologies, the modest skills required to adopt or be able to use them and most importantly, the high potential to adapt the subsisting locally building materials and technologies are key attributes that make the building materials and technologies innovated by NHBRA not only attractive, but also responsive to and appropriate for expediting realization of the Housing Finance Project.

(iv) NHBRA products are likely to have a large market, particularly because of the huge unmet housing deficit especially for low and middle income groups. The potential to lower costs of the housing, through self-help initiatives and on-site making of building materials such as bricks and roofing tiles are also critical attributes. Needless to add that housing requirements are also likely to increase significantly in the coming years, primarily because of high population growth rates.

(v) Housing is increasingly becoming an agenda in the government policies and plans. A number of public institutions such as NHC, PPF, TBA, Watumishi Housing Agency and NSSF, are aggressively exploring and pursuing options to deliver affordable housing especially to low-income households including public servants. The demand of NHBRA materials and technologies is therefore likely to increase among middle income group also.

(vi) NHBRA has inadequate testing machines. It presently lacks modern and heavy duty equipments for testing road construction materials and compactness of roads. Some of laboratory test machine are outdated.

(vii) The documentation and dissemination of materials and technologies innovated by NHBRA is overall poor. The documentation system is largely manual and information poorly managed. Besides, the current modes of documentation and dissemination of NHBRA materials and technologies are not easily accessible or user friendly. Consequently, in most cases, there has been little use beyond the specific project areas.

(viii) NHBRA is unable to upscale the use of its materials and technologies inter alia because of resource paucity (e.g. shortage of financial and manpower) and poor link with the private sector, especially large scale producers of building materials and prospective home- builders. Poor marketing strategy is particularly a weak link in the NHBRA product promotion chain.

(ix) There is a weak institutional inertia and strategy to transform NHBRA in line with the changed socio-economic and political environment in the country. This, coupled with inadequate local capacity building in the areas and project sites (and areas adjoining

them) has led to slow diffusion and poor adoption of NHBRA materials and technology.

(x) There is a problem of low visibility of most demonstration projects built by NHBRA in especially up-country areas. This, in turn, means that very few of the would-be home-builders are informed or aware of the low cost and affordable, but good quality materials and technologies innovated by NHBRA.

(xi)NHBRA does not have a mechanism to make follow-ups on how its products are performing or whether or not their clients are satisfied. The point here is that for a research institution such as NHBRA, the challenge is not only to produce innovative affordable products, but to also monitor customer satisfaction, changing perceptions and challenges emerging during the lifetime of the product.

(xii) NHBRA has directly and indirectly collaborated with a number of public institutions including TBA, NHC, GPSA, and VETA as well as with NGOs, such as CCI and WAT-HST. The collaboration, with these organizations are however not institutionalized.

(xiii) The current 2.29 acres piece of land that accommodates NHBRA at Mwenge in Dar es Salaam is too small given the anticipated expansion of NHBRA activities in future.

(xiv) NHBRA materials and technologies have high potential to contribute towards the realization of the objectives of the Housing Finance Project, especially promotion of affordable housing. However, at present it does not have the requisite capacity to fulfil this very critical and noble role.

10.2 Recommendations

In order to address the numerous challenges and other concerns outlined the preceding chapters and enable NHBRA not only effectively fulfil its mandate and functions of research and dissemination of building materials and technologies, but grow into a vibrant Centre of Excellence in building materials and technologies as well as be able to take advantage the unfolding opportunities, the following measures are **recommended**.

10.2.1 Institutional Transformation

NHBRA is an old research institution that has specialised on building materials and technologies. It has grown from a department of the Ministry of Lands, Housing and Human Settlements

Development to a semi-autonomous agency of the government. The transformation has implied more functions and expectations;

(i) The current status of NHBRA as Government Agency under the Ministry of Lands, Housing and Human Settlements Development does not adequately befit an institution holding and playing strategic functions such as those being handled by NHBRA. This is because as an Agency, the capacity to make decisions is highly restrained for it does not have a Governing Board but an Advisory Board. Besides, its capacity to mobilize resources i.e. compete with other institutions involved in research activities for research funding, or establish networks and partnerships with peer institutions within and outside the country is also limited.

It is therefore r**ecommended** that NHBRA be transformed into a semi-autonomous research Institute i.e. into a National Housing and Building Research Institute (NHBRI), under an institution with strong research culture. This is deemed important so as re-invigorate research culture and provide the appropriate environment for the proposed Institute to discharge its functions efficiently. Corollary, it is also recommend that the Ministry of Lands, Housing and Human Settlements Development takes up the matter that concern the future nurturing of the proposed Institute with potential institution with the purpose of exploring the best modalities for integrating or cooperation with the proposed Institute. What is important is that regardless of whether the Institute is under the Ministry of Lands or any other research institution, its focus on applied research that makes a difference in the delivery of appropriate and affordable housing especially for low-income groups shall be upheld. Decision on the best location or modalities to support and nurture the proposed Institute into a Centre of Excellence could also be done through consultations with key stakeholders. The proposed transformation will also entail preparation and operationalisation of various instruments including research policy**.**

(ii) Due to the decline of research outputs and eroded research culture, the inclination of most of the current staff is towards consultancy rather than research. It is therefore **recommended** that NHBRA internal structure of NHBRA be reorganized also. The restructuring process shall put a high priority on having an appropriate organo-structure; recruiting staff (new blood) with strong interest and focus on research. This should include a couple of PhD holders. It will also involve re-orienting and capacity building of the young NHBRA staff currently on-post to mainstream research in their future career development.

(iii) Significant resources will be required to establish and operationalise the Institute as a research entity. In order to enable the Institute discharge its research and dissemination activities efficiently, it **is recommended** that the Government gives high priority to

establish a levy on all producers and distributors of building materials and technologies. Revenue from this levy will be used to build capacity of NHBRI; fund research on low cost building materials and technologies; promote documentation and dissemination activities including low income housing support services.

(iv) Future expansion of NHBRI at its present site in Mwenge is highly restrained particularly because much more office space for laboratories and outdoors exhibition areas will be required. In addition NHBRA does not have branches upcountry. It is therefore **recommended** that NHBRA takes immediate action to search for and acquire adequate land within and outside Dar es Salaam for future relocation and expansion.

(v) NHBRA has not effectively tapped the enormous potentials which exists among its peer institutions. Synergies with these institutions would particularly help in dissemination and enhancing public outreach activities. Therefore concurrent with the proposed transformation of NHBRA, it is **recommended** that NHBRA takes deliberate efforts to consolidate partnerships with peer institutions within and outside the country including universities, technical colleges and VETA and SIDO so as to enhance synergies through engagement in joint research and dissemination projects. It is also important that NHBRA establishes a formal forum or platform for specifically sharing experiences on building materials and technologies with peer institutions

10.2.3 Affordability and Availability of Building Materials and Technologies

Although NHBRA had analyzed has established occurrence of seven (7) types of building materials in the country, so far it has innovated 4 technologies and produced four main building products namely: soil stabilized cement bricks/blocks; interlocking bricks; sisal fibre reinforced concrete tile; and Pozzolana and Pozzolime. Fieldwork showed that generally these materials and technologies are not readily available to the would-be users. In fact currently, NHBRA does not have any outlet outside its headquarters at Mwenge, Dar es Salaam.

The materials are overall affordable especially in cases where there is on site production and self help inputs. On the other hand, the technologies available such as IBPM, Cinva–ram block, block press machines, roof tiles moulds, are unaffordable and uneconomical for a prospective house builder to purchase and own the machines innovated by NHBRA. It is therefore **recommended** that:

(i) NHBRA should sign a MOU with VETA, SIDO and Folk Development Centres which have wide networks distributed in the regions and districts, so as to expedite the production, training and distribution of technology. In this respect, NHBRA shall retain the property rights and be responsible for monitoring the performance of the technologies.

(ii) In order to boost the use of NHBRA materials and technologies it is also important for NHBRA to initiate discussions with the PMO-RALG with a view to re-establish building brigades. Initially, the building brigades are proposed to be established at district level, later

options for ward level brigades will be explored. These shall in the long-run grow and constitute incubators of NHBRA technologies.

(iii) While the focus of NHBRA on researching and making building materials and technologies available and affordable to low income prospective homebuilders is applauded, it is **recommended** that opportunities for mass industrial production of some of the building materials and technologies (i.e. inter locking bricks) be explored. This is an area where NHBRA will have to work with large producers of building materials such as proprietors of cement factories.

10.2.5 Improving the information documentation system

The current library is congested and lacking adequate space, the necessary ICT and other basic equipments. In order to revamp the documentation system and ensure that NHBRA is able to reach and support potential consumers of its products as well as establish firm links with other research institutions, it is **recommended that NHBRA:**

(i) Recruits a librarian/documentation expert and an ICT expert to be responsible for information organization and management, and exploration and establishment of links with peer research institutions within and outside the country;

(ii) Rehabilitates the documentation centre. This includes provision of adequate space, re-organization of the physical space as well as the provision of adequate and appropriate furniture;

(iii) Equips the library with an automated/digital information documentation and retrieval system including an on-line database to host all the publications of NHBRA as well as provide an on-line catalogue search for wider reach and access;

(iv) Improves access to technologies by potential users upcountry, by linking NHBRA information services with district libraries and tele-centres;

(v) Transforms the existing hard-copy materials into more user-friendly and convenient documentation formats CDs and DVDs that can be easily accessible to potential users.

(vi) Prepares and operationises a research development and information policy. The policy should provide for information documentation protocols as well as regulate/guide research, documentation and dissemination activities undertaken by NHBRA staff. It should also clearly outline the incentive so as to boost interests and commitment to research rather than consultancy.

10.2.6 Strengthening Dissemination of NHBRA Products

NHBRA has operated with several dissemination modes and methods. These include the use of print and electronic media (newspapers, leaflets and datasheets and TV, radio, webpage respectively) exhibitions and demonstration projects; workshops, conferences and sensitization seminars. Generally, these dissemination modes and methods have not received much funding leading to low visibility and impact of NHBRA materials and technologies. NHBRA is also

lacking appropriate dissemination modes and methods that depict varying contexts (rural and urban) and needs of the society.

Also publications produced by NHBRA in recent years have declined remarkably over the last 10 years. Most importantly, NHBRA webpage is often not active. Most of the sensitisation seminars offered, by NHBRA were demand-driven therefore clients had to invite and finance NHBRA to conduct the seminars. This means that a large section of the potential users of NHBRA materials and technologies are excluded from the training.

It is, therefore, **recommended** that:

(i) NHBRA prepares a marketing strategic plan and programme for its products. This shall include preparation of the plan, strategies and activities, and an action plan.
(ii) NHBRA consolidates and taps the potentials including networks of the well-established institutions such as VETA, SIDO and Folk Colleges so as to reach more prospective users of NHBRA materials and technologies at local levels.
(iii) NHBRA gives priority to the development of its website, upload the relevant materials and regularly update it.

10.2.7 Enhancing the Roles of NHBRA in the Facilitation of the Housing Finance Project (HFP)

Availability of affordable building materials and technologies are prerequisites for the realization of the HFP objectives. In order for the NHBRA to facilitate and play a major role in the HFP activities, it is **recommended** that:

(i) NHBRA builds its capacity in the areas of human resources, basic facilities and laboratory equipments in order to be able to carry out more research and innovation.
(ii) NHBRA prepares a comprehensive plan to promote awareness on their products as well as occurrences of raw materials for affordable housing in many parts of the country.
(iii) NHBRA liaises and seeks support from the private sector to engage in mass production of the innovated technologies.

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APPENDICES

APPENDIX 1

Table 1: Sources of data for the study by thematic areas

Thematic issue (ToR) / Source of data	Revie-w availa-ble materi-als and techno..	Availability & affordability	Impact of research findings	Information documentation system	Dissemination programmes and methods	NHBRA Facilitation of HFP	Perceptions on technologies and building materials by NHBRA	Experience from other countries	Link with the private sector
Literature review (secondary sources)	×		×	×	×			×	×
Interviews with NHBRA officials	×	×	×	×	×	×	×	×	×
Interviews with selected stakeholders including private, public actors, community leaders	×	×	×	×	×	×	×		×
Interviews with various producers, users and beneficiaries (private, public, civil societies, media houses etc.)		×	×	×	×	×	×		×
Photographing		×	×	×			×		×

Stakeholders feedback consultation	×	×	×	×	×	×		×	×
Focused group discussions	×	×	×	×	×	×	×	×	×

APPENDIX 2

Table 2: Data collection methods, tools and deliverables as per TOR

ITEM NO.	TOR (Thematic Issues)	METHODS	TOOLS	DELIVERABLES/OUTPUTS
2.1	Review of available building materials	• Secondary data review – reports, scholarly publications, data sheets including manuals • Primary data collection	• Systematic literature • Observation • Photographing • FGD	• Report/chapter on available building materials, technologies including illustrations i.e. maps
2.1.1.	Review of available low-cost technology	• Secondary information - reports papers, manuals, data sheets, • Primary data collection	• Documentation • Observation • FGD • Photographing	
2.2	Availability and affordability of NHBRA building materials and technologies	• Secondary data review • Interviews with users and beneficiaries • Interview with collaborators/institutions (public and private sectors	• Documentation • Questionnaire • Observation • FGD • Stakeholders consultative workshop	• Report/Chapter on affordability, trends and availability of specific building materials and technologies graphics illustrations.
2.2.1	Perceptions on NHBRA technological and building materials	• Interviews with stakeholders • Literature review	• Checklist questions • FGD • Stakeholders consultative workshop	• Reports
2.3.1	Review of impact and relevance of research findings	• Discussion with researchers and scholars • Documentation of cases from field studies	• Checklist questionnaires • documentation • Photographing • Mapping • FGD • Stakeholders consultative workshops	• Report/chapter on impacts and relevance of NHBRA research findings
2.3.2	Review of experiences from other countries	• Literature search;	• Internet • Documentation	• Chapter on experience and lessons from other countries

2.4	NHBRA Information Documentation System	• Secondary data • Discussion with management and librarian • Communication technology	• Documentation • Observation • Checklist questionnaires • FGD • Website and internet • Info sharing etc • Stakeholders consultation workshop	• Chapter on NHBRA information and documentation system including weaknesses and potentials for improvement
2.5	Dissemination of programmes	• Secondary data • Seminars/workshops • Interview of key stakeholders to identify weaknesses, potentials, adequacy or capacity, storage retrieval processes	• Documentation–soft and hard materials o Journals o Brochures o Webpage o Exhibitions o Media o Stakeholders consultation workshop	• Chapter on dissemination system and programmes including strategies for improvement or address the problems
2.6	Facilitation of HF Project by NHBRA	• Primary data • Secondary data on local and external experiences • Interview of key stakeholders including public, private and civil societies.	• Checklist interviews • Focus group discussions (FGDs) • Stakeholders consultation Workshop	• Recommendations on how NHBRA can facilitate and expedite the realistic objectives of the Housing Finance Project

APPENDIX 3

Table 3: List of contacted persons

Respondent	Number	Remarks
NHBRA Officials	6	Consultations were made with NHBRA on sharing of the preliminary findings
CCI	8	CCI officials, site technicians, and Federation leaders
TBA	1	Executive Director
NHC	1	Director of Innovation
VETA	1	Discussions were held with the VETA officer in charge of training youth groups in the districts on NHBRA technologies
WAT-HST	1	Civil Engineer
ARU	3	Architect, Quantity Suveyor and Urban Planner
Real Estates Companies	2	Contractor, Real Estate firm
Contractor Class Five	3	House construction
Individuals and informal firms involved in bricks production	3	These are small scale enterprises involved in the production of brick and blocks
Fundis (local artisans)	7	These constitute those who had been trained on NHBRA technologies
Bricklayers of interlocking bricks	10	Women group involved in the construction of houses
Formal producers of building	5	These are the owners of the firms with different,

materials		professional backgrounds e.g. Economist, Engineers, Quantity surveyor and material technicians
Kintingu to provide details	3	Men group involved in the construction of houses
Large scale producers of cement	2	Mbeya Cement Factory
Trainees in using building materials and technologies	13	In rural areas in Bagamoyo, Biharamulo, Kabuku Handeni, Mafia
Ministry of Land Housing and Human Settlements Development		Former Director of Housing
National Construction Council	1	Former Executive Director
Professional bodies	1	The officer is an architect
Officials of Temeke Municipality	2	One quantity surveyor One engineer
Officials of Temeke Municipality		One Architect
Community Development Officers	1	The officer works with African Gold Barrick Mining Company

APPENDIX 4

The PESTEL Analysis Model

Since NHBRA is an institution that is research and producing materials and technologies for use by a number of clients or users it is necessary to track the environment in which it is operating, marketing and disseminating its products. In particular, it is necessary to have insights on the political situation, economic factors, cultural factors, technological innovations various prevailing legislations and environmental concern issues that are important in researching markets and the dissemination of NHBRA materials and technologies. In regard, this section presents the Political, Economic, Social, Technological, Legal and Environmental analysis of the project. It attempts to highlight the importance of various factors that may influence the market and dissemination of NHBRA materials and technologies. The importance of various variables are identified as likely (>), unlikely (<), undefined (=) as indicated in tables below.

3.4.1 POLITICAL FACTORS

Politically, Tanzania is a stable country and it is expected that political stability will be maintained over the years to come. It is also expected that the government shall not significantly change fiscal or any other policies, such that might result in adverse effects to the economy and the development and dissemination of NHBRA materials and technologies in the country. However, since NHBRA do operate within the government framework, some political factors which can affect the use and promotion of NHBRA materials and technologies are identified as outlined in Table 1.

Table .1: Analysis of political factors for NHBRA products

Key Factors	Importance
• Unfavourable political environment	<
• Political influence on the successful adoption of NHBRA materials and technologies	=
• Low interest among politicians in promoting the NHBRA materials and technologies	=
• Interest among government departments and ministries to increase funding to facilitate production of NHBRA materials and technologies	=
• Interest of local and external financiers to support development and dissemination of NHBRA materials and technologies	=
• Changes in polices and government priorities in promoting research in building materials and technologies	>

KEY: LIKELY (>), UNLIKELY (<), UNDEFINED (=)

3.4.2 ECONOMIC SITUATION

The Tanzanian economy has been growing at an average of 7 per cent per annum in the past decade. The increase is due to the favourable investment environment, increased inflow of FID and the rise the productivity in economic sectors. It is expected that the economy and construction industry will continue to grow and result in an increase in expenditure for NHBRA materials and technologies, including housing. It is also expected that the private sector will continue to participate in the various sectors of economy including the housing units delivery. Table 2 provides a number of economic factors that can affect the use and promotion of building materials and technologies.

Table 2: Analysis of economic factors for NHBRA products

Key Factors	Importance
• Low income among people to afford NBRA materials and technology	>
• Local economic condition and trends	>
• Good economic growth prospects	>
• Trade, tariffs and taxes introduced	>
• Increase in inflation and hence affecting cost of living and NHBRA materials and technologies	>
• Increase in interest rates which can affect the housing financing by financial institutions	>
• Fluctuation of exchange rate that will affect the cost of imported research equipment and materials for fabricating machines and NHBRA technologies	=
• Unemployment level in the country	>

KEY: LIKELY (>), UNLIKELY (<), UNDEFINED (=)

3.4.3: SOCIAL FACTORS

NHBRA operates as government institution. However, there are a number of social factors that determine the use and market for NHBRA materials and technologies in the country. They are demographic and cultural trends that have a bearing on saving attitudes as well as demand and supply of housing units. They also affected the use and adoption of NHBRA materials and technologies. Rapid population growth rate especially in urban areas (4.7 per cent per annum) has an effect on supply and demand for housing. Given demographic changes and demonstration effects, consumer opinion and preferences have an effect on the demand of the NHBRA materials and technologies and need to be taken care of. Table 3 provides the details on the number of social factors that affect the use and promotion of NHBRA materials and technology.

Table 3: Analysis of social factors for NHBRA products

Key Factors	Importance
• Brand preference in building materials and technologies among the populace	<
• Change in life style and saving culture	>
• Consumer attitudes and opinions on the NHBRA building material and technologies	=
• Views of the media and general public on NHBRA building materials and technologies	>
• Trends in population growth and demographic changes	>
• Culture attributes of owning house security	>

KEY: LIKELY (>), UNLIKELY (<), UNDEFINED (=)

3.4.4: TECHNOLOGICAL FACTORS

One of the strengths of NHBRA is the ability and experience in development of material and technologies that use local available material. In particular, the agency has developed technologies that are widely used such as sand and cement blocks and as well as soil cement interlocking bricks. Nonetheless, technologies that are being imported are used in the country, as well. In this regard there are a number of technologies available in the countries that compete with that of NHBRA.

Furthermore, the adoption of the materials and technologies by local producer and builders depends on consumers' preference and buying trends. The technology for soil cement interlocking bricks has not been widely adopted in the country. This shown by the low level trends in purchasing and using materials and the technologies developed by NHBRA, compared to the known local technologies or the imported ones.

For an institution like NHBRA, there is a need to develop and own the materials and technologies. This can also enable the agency to recoup the costs for developing materials and technologies as well as funding research activities. This can be done by the patenting and licensing technologies. The available intellectual property rights and other laws provide an opportunity for NHBRA to develop technologies and claim their ownership. Table 4 provides the details on the technological factors that affect the use and marketing of NHBRA technologies.

Table 4: Analysis of technological factors for NHBRA products

Key Factors	Importance
• Availability and use of modern building and materials technologies	>
• Availability and easy use of NHBRA building materials and technologies	>
• Legislation in technologies and patenting of NHBRA products	=
• Consumers knowledge on NHBRA building materials and technologies	=
• Consumer preferences on NHBRA building materials and technologies in favour of other technologies	>
• Comfort attribute of NHBRA building materials	>
• Inadequate development in technological related facilities	=
• Aesthetics and beauty attributes of NHBRA developed building materials	>

KEY: LIKELY (>), UNLIKELY (<), UNDEFINED (=)

3.4.5 LEGAL FACTORS

The NHBRA was established in 2001 after the government enacted the law on the Executive Agencies in 1997 and Regulations of 1999. It is anticipated that in the near future no major changes in the legal provisions that established NHBRA shall take place and that legal provision available for using building materials. Furthermore, the application of the competition regulations in the building materials and technology industry shall continue to be favourable for marketing and use of NHBRA materials and technologies. Moreover, regulatory and professional bodies have not yet raised any concern on the use of NHBRA building materials and technology. The details on some factors that affect the use and promotion of NHBRA materials and technologies are presented below (Table 5)

Table 5: Analysis of legal factors for the for NHBRA products

Key Factors	Importance
• Changes in legal framework for running government agencies	=
• Changes in competition regulations in the construction industry	>
• Adoption of environmental regulations in the production of NHBRA building materials and technologies	>
• Regulations in the construction industry concerning the use of local available NHBRA building materials and technologies	>
• Changes in the mandate of regulatory bodies in the construction industry	>

KEY: LIKELY (>), UNLIKELY (<), UNDEFINED (=)

3.4.6 ENVIRONMENTAL FACTORS

The adoption and use of the NHBRA materials and technology may adversely affect the environment. In particular, the use of available local materials such as sand, soil, sisal fibre and water for making building materials have effect on local ecology. Also extensive use and transportation of materials imply high energy consumption which may in turn affect the environment.

This may awaken environmental concern among the local and international organisations. However, based on the environmental impacts consideration, the production and use of the NHBRA building materials and technologies poses a threat on the environment, especially the use of cement.

There are number of environmental factors that may affect the production adoption and the marketing of NHBRA materials and technologies. They are presented in Table 6.

Table 6: Analysis of environmental factors for NHBRA products proposed hotel

Key Factors	Importance
• Environmental degradation impact	=
• Pollution problems such as air and water	<
• Ecological effects of producing building materials and technologies	<
• Destruction of general environment	=

Key: likely (>), unlikely (<), undefined (=)

APPENDIX 5

Table 5: NHBRA Evolving Research in Materials and Building Technologies

S/No	Elements	Type of Materials	Publications	Remarks M& T/POLICY
1	Walls	Binding	Baradyana, J.S.: (1987); Properties of Some Organic Wastes in Concrete Using Cement as a Binder	Findings from this research have not been fully realized. Complementary works done by Mwakyusa (2008) expounded on some of the issues.
2		Wall panel	Svare, T.I.: (1974) Better Burnt Bricks	There is wide use of burnt bricks in the country but no particular building standard has been formulated.
3		Plaster	Kajasger- Rudnistski (1984) On plastering of mud block walls for low cost housing**,** BRU working report ; WR no. 38	No further work has been done on this important area, potential high cost saving area
4		Walling	Moriatty and Therkildsen(1973) Lateric Soil Cement as Building Material	Based on cement stabilization of soils, no further studies.
5		Walling	T. I Svare (1974) Better Burnt Bricks	Widely used technology in several parts of the country, no further studies
6		Joinery	Nils Lunborg: (1976); To Choose Timber for Building	This is more of a guide on use of timber. Further work is required to develop relevant standard.
5		Combined	Demonstration Houses in Morogoro Sisal Authority (1978) Kabuku, Tanga (1979) and Capital Development Authority (CDA) – Dodoma (1981)	These are successful stories about the projects launched in the areas. No follow up studies by the NHBRA since then which would have reviewed the expected results from the original works.
6	Roofs	Roofing Sheet	Kitundu, H.H.J.: (1981); Manual Production of Sisal Reinforced Roofing Sheets	Although no further research documentation is available on use of sisal fibres, the NHBRA has been producing and propagating use of the sisal as reinforcement materials for roofing sheets

a) Research Carried out in Building Regulations and Standards

S/No	Type	Sector	Publication	
1	Housing	Standards	T. I Svare (1974) Minimum Requirements for Permanent Single Storey Houses, Technical pamphlet, No.2	There was a follow up on this work in the drafting of the Proposed National Building Regulations in 1980 and 2001 but no further progress.
2	Housing	Building Products	NHBRU(1977), Tanzania Building Products' Catalogue (available also in Swahili- Kitabu Kidogo cha Vifaavya Ujenzi Vitengenezwavyo Nchini Tanzania Mikoa Arusha, Kigoma and Mbeya*)*	No update on this documentation. Apparently the list of building materials in use has not significantly changed.
3	Housing	Typology and Development	V.H Kimati, H. Helland, Z. Poonja (1976) Housing Development In Kilimanjaro, Nhbru, Dar Es Salaam, Working Report	Another study on Gogo house done in 1979 and in Misungwi in 1993 by Livin Mosha. The village museum in Dar es Salaam has a collection of traditional rural housing typologies. there has also been some research work in the areas of rural housing that the NHBRA ought to have been interested in and reflect in their research on use of local materials this has not happened.
4	Housing	Rural	C.Boalt(1975)Housing in Tanzania- A pilot study of four villages in transition, NHBRA working report	
5			Edvardesn K.I and Hegdal, B.: (1972); Rural Housing in Tanzania: Report on Pre-Study.	

b) Research Carried on Housing Condition

S/No	**Type**	**Sector**	**Publications**	**Remarks**
1	Housing	Housing Quality	Michael L.I. Mpuya, Rune Karlsson and Stefan Dahlgren(1988): Housing Conditions in Tanzania	This was a pioneer work towards what could be said 'establishing standards for decent homes in Tanzania'. NHBRA has not followed up this work. In 1991Hoet Smith carried out
2			Mpuya, M., Mponzi, T., Karlsson, R. Hugman, P.,	

			Mwafongo, F., Yatera, J. and Dahlgren, S.: (1990); Housing Conditions in Tanzania (Illustrations)	Housing Condition Study which complemented the NHBRA Study. National Census have over the years addressed household surveys which provide good basis for the NHBRA work on ways of improving rural housing condition .
3		Climate Change	Mponzi, T.F. and Mlemble, J.A.: (1991); The Importance of Better Housing in Withstanding Natural Catastrophes- (BRU, Tech. Pamphlet No. 4).	

d) Housing Design and Construction

S/No	Type	Sector	Publications	Remarrks
1	Building	Construction Management	George C. Mgoha: (2000); Managing a Construction Project in Tanzania	NHBRA has very limited documented research on the subjects of construction management for the technologies that they have been researching on for years.

APPENDIX 6

Technologies and Production Process of NHBRA materials

In building construction, technology in simple terms means using the right techniques and knowledge to assemble or put up together systematically and correctly different building products and materials to serve for any intended purposes and specific functions.

Interlocking Bricks

In the production of interlocking bricks, ordinary and suitable soil can be used to produce a variety of these building materials products. However, soil stabilization is necessary and can be applied to the soil and improve its strength in order to enhance basic properties such water absorption, a process which can be done by compacting and binding the soils grains.

Basically, such improvements can be done by mixing soil as a basic raw material with other materials which are having binding properties. NHBRA is applying this technology of modifying soil by adding mineral binders to produce Interlocking bricks (IB). The most common applied mineral binder is cement. The production process and steps adopted by NHBRA is as presented below.

(a) Identification process of suitable soil

(i) Identifying and collecting soil sample is very crucial. In normal circumstances, the best soil is that which contains a mixture of sand and silt. The top soil, at least up to 50 centimeters, depending on the site location, is usually removed because it contain organic contents which may be harm the quality and strength, and eventually weaken the performance of the material.

(ii) After the first stage, it is then necessary to do a pre-test before the soil is passed (recommended) for use. The pre-test is conducted by using the Bottle test. This test can reveal the soil contents, i.e. clay, sand and silt in terms of percent. If the soil contains clay percentage below 10%, the soil is regarded as not suitable, since it will eventually be difficult to handle it from the production machine. And if the clay content is more than 40%, the soil is also regarded as not suitable, since it will easily be subjected to cracks formation when the manufactured brick is dry. Therefore based on these facts, the suitable clay content should lie between 10 and 40%, the condition in which the produced brick will not be subjected to the undesired effects.

Apart from the Bottle Test, Shrinkage test is another test which is performed to test the suitability of the soil. The result from this test can guide the brick maker to systematically determine the mix proportion of sand and the binder (cement). The results from these tests are adopted, and normally, one standard bag of cement (50 kg) can produce 70 to max 120 bricks, depending on the properties of the local soil and the desired quality by the client.

Once the suitable soil has been identified and recommended, it is advisable to prepare test bricks using a variation of mixtures, and at the end, choosing the best mixture with the best results.

(b) Bricks making process

This process involves different stages including;

(i) Drying the soil
This is important to make it possible and easier to sort and sieve the soil properly

(ii) To sort (sieve) the soil
This process helps to remove large soil particles which may make it difficult to mix the soil. In this process, a nominal sieve size of 5mm diameter is recommended.

(iii) Mixing of soil and cement
Mixing:
In this process, dry soil is mixed with dry cement in specified proportions in order to get a standard mix. This should base on results the results from the previously conducted shrinkage test.

Adding water:
After mixing the soil with cement in dry form, water is added very systematically and slowly while mixing is continuing. The amount of water required should only be optimum and enough to make the mix ready for use (with good workability), that is, it should not be too wet and not too dry. This condition can be filled with bare hands by an experienced person.

(iv) Stages in making Interlocking bricks
Normally, there are four stages involved in the process;

1. To fill the soil in the machine using the right mix proportions
2.To compact the soil as per specifications
3. To press out the brick from the machine
4.To carry and place the brick in the prepared drying place

(v) Drying and strength gaining

The produced bricks should be kept under shade and cured (usually in the morning and evening) for a minimum of 7 days. Thereafter, the bricks should be kept for another 7 days so that the water is absorbed (hydrated) for a maximum strength gaining. The bricks can be produced in

desired sizes, e.g. Half, Quarter, One-eighth, etc.Curing and drying processes are basically essential for all types of bricksmade with mineral binders.

6.1.6.2Sisal Fibre Reinforced Concrete (FRC) Tiles

Sisal fibre reinforced concrete tiles (commonly known as FRC) can be manufactured by using a mixture of sand, cement and sisal fibres in specified proportions. The tiles have good appearance and an attractive outlook, while the colours, which may be a customer desire factor, can be made flexible.

(a) Raw materials

(i) The raw materials are basically

(ii) The mixing ratio
- The mixing ratio of cement and sand is 1:3
- The water cement ratio (W:C) ranges from 0.65 to 0.75 (higher than in ordinary
- Portland cement concrete, which is at an average value of 0.5)

(iii) Raw materials requirements for an FRC tile (in kg);

(iv) Production Stages
(i) Preparation of sisal fibres by cutting to 10-15 mm lengths and weighing specified weight
(ii) Preparation of the mix:
Dry mix: Mixing cement and sand first, then colour and finally apply sisal fibres
Wet mix: Is the mixture of the dry mix added with water

(iii) Stages in production of roofing tiles;
- A nylon paper is placed on top of the tile machine and pressed by a metal frame
- The mix is filled in the metal frame and compacted (by using a connected electric
- Mortar run by a car battery to run the tile machine)
- Then the frame is removed and the paper with the mix is moved to the mould to get
- desired shape of the tile
- The tile is finally left for 18 hours in the mould

(iv) Strength gaining and drying
After 18 hours, the tiles are taken from the moulds and soaked in water for a minimum of 28 days and then removed. From this point, they are left for 7 days to dry. After this stage the tiles are ready for use. However, in connection with the production process and the power required,

the challenge here can be the continuous availability and constant supply of power to run the mortar connected to the tiles machine.

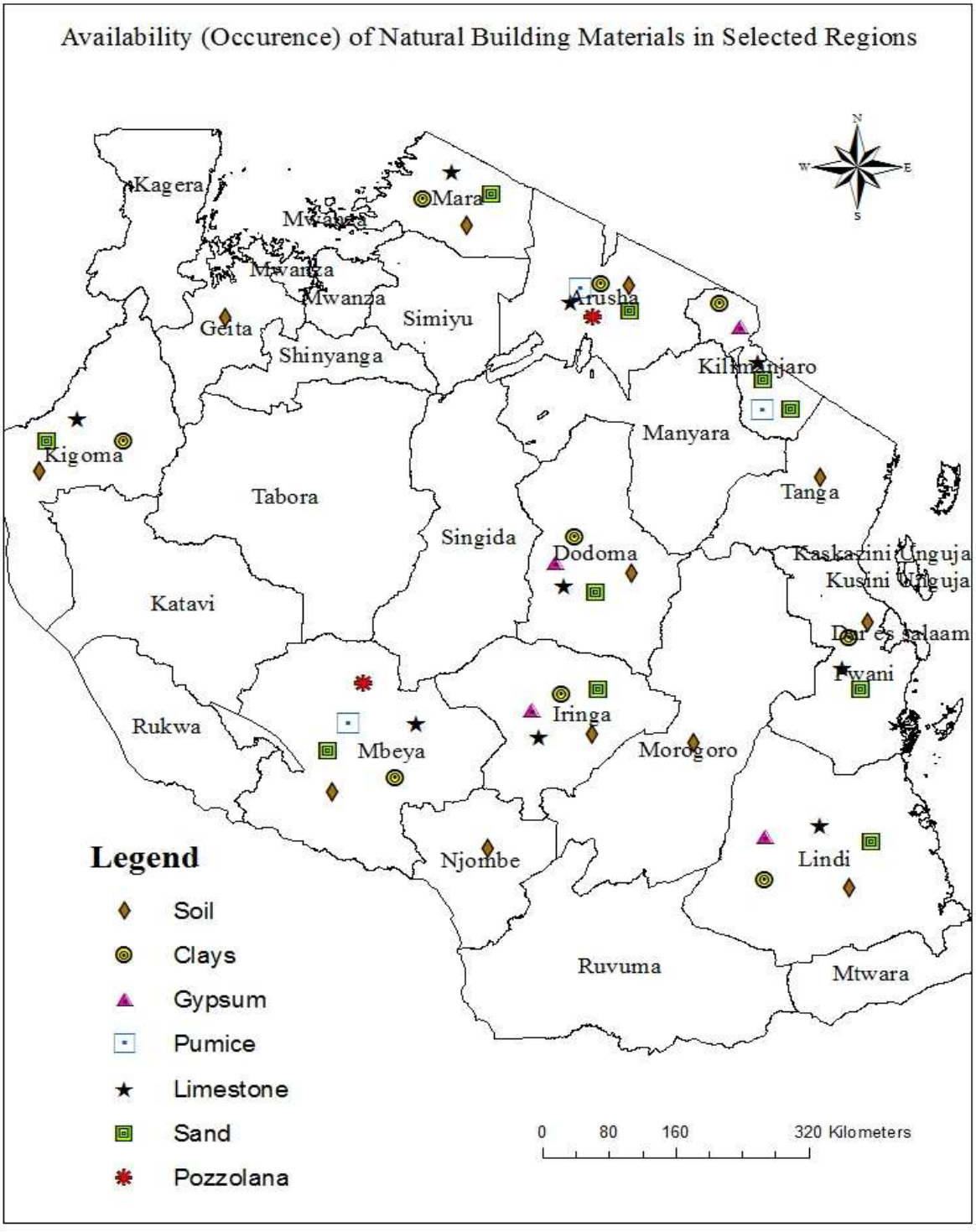
(c) Production of Roof tiles
In principle, the production of roof tiles require the following tools;
- Tiles machine
- Tiles moulds
- Plastic papers

During the production of tiles, the machine is connected to a car battery in order to run the mortar. The mortar vibrates the machine, which in turn spreads and compacts the mix as may be specified. This process is necessary in order to improve the properties of the tiles. It is recommended to place the machine on a table to provide a reasonable and easy working height.

(b)Technical Data

(c) Roofing Guiding information
The guiding information is usually based on the technical data and detailed instructions provided by NHBRA. The photo below shows a demonstration tiles model at NHBRA HQs in Dar es Salaam.

APPENDIX 7


Availability (Occurence) of Natural Building Materials in Selected Regions
N
W
E
S
Kagera
Mara
Mwanza
Mwanza
Mwanza
Simiyu
Arusha
Geita
Shinyanga
Kilimanjaro
Manyara
Kigoma
Tabora
Tanga
Singida
Dodoma
Kaskazini Unguja
Kusini Unguja
Katavi
Dar es Salaam
Pwani
Iringa
Rukwa
Mbeya
Morogoro
Njombe
Lindi
Ruvuma
Mtwara
Legend
Soil
Clays
Gypsum
Pumice
Limestone
Sand
Pozzolana
0
80
160
320 Kilometers