

RESEARCH ON CERAMIC FITTINGS TO SUPPORT AFFORDABLE HOUSING

Research | Materials | Design | Manufacturing



REPUBLIC OF KENYA



STATE DEPARTMENT FOR
PUBLIC WORKS



KENYA BUILDING RESEARCH
CENTER



UNIVERSITY OF NAIROBI

Introduction

Kenya has an estimated 12.1 million households with an annual demand of 250,000 housing units against an estimated annual supply of fewer than 50,000 units. Considering that the building materials and components account for 60% of the total construction cost, this statistic translates into more than double the number of sanitary wares required to meet housing demand per annum. One of the challenges encountered in the provision of housing is escalating building costs attributed to inadequate innovation in low-cost building technology, building materials, and components. Close to 21 million people in Kenya use unsanitary or shared latrines. Only two in three households have satisfactory sanitation facilities. 5.6 Million people lack latrines and defecate in the open spaces, alleys, bushes, forests, or grasslands polluting the environment and spreading diseases such as diarrhea and cholera.

The aim of this research was to investigate local materials that can be used in the design and production of sustainable low-cost ceramic toilets, not only to bridge the diverse issues of sanitation and health but also to provide an affordable building material and component solution to support affordable housing. The research sought to address issues of industrialization and universal health propounded as well as spur manufacturing and meaningful employment opportunities.



Dilapidated pit latrines in a learning institution

Research Gap

The majority of Kenyans are living in health-threatening conditions and this is because they cannot afford appropriate housing with necessary amenities such as sanitary fitting. The revenue spent on the importation of ceramic sanitary such as wash hand basins, water closets including toilet, sinks, sanitary fittings, urinals, and bathroom vanity is substantial. Rising housing need translates into increased demand for sanitary toilets. Poor sanitation also costs the country close to 27 billion shillings annually due to increased health care needs, losses in productivity while accessing healthcare by the sick, premature death amongst children, and time lost in the search for convenient toilet facility.

Objectives

The main objective was to investigate the local production of ceramic fittings that could support the affordable housing program. The other research objectives were:

1. Analyze the suitable soils (minerals) that could be used in the manufacture of ceramic fittings.
2. Design and develop a prototype of a ceramic toilet.
3. Develop guidelines for the manufacture and production of ceramic toilets.
4. Identify design opportunities in the production and manufacture of ceramic toilets.

Methodology

Research methodology was guided by principles of innovation, sustainable development, affordability, public participation and inclusivity. The research was anchored on literature from the housing development in post independence era in Kenya and other countries. Secondary data was collected from the Kenya Building research Centre, University of Nairobi, KIRDI, SAJ Ceramics, Kazuri among other sources. The project employed mainly design research methods alongside other social research methods including ethnography (Creswell, 2007) and case study (Yin, 2002).

The main activity of the research was design and development of ceramic fittings and therefore, the process was divided into the following five phases: Material sourcing and understanding, material analysis, Design and Production of prototype and Dissemination.

i. Field Visits



Industrial visit at KIRDI in Nairobi



Industrial visit at SAJ Ceramics



Clay Products manufactured at KIRDI

ii. Soil Sampling and analysis



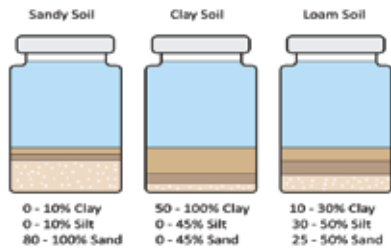
Clay sampling in Mukurweini, Nyeri



Clay quarries in Nunguuni, Machakos



Clay excavation in Mukurweini, Nyeri



Clay analysis for suitability



Clay testing and analysis



Collected Clay samples for testing

iii. Soil Preparation



Dry clay crushing



Clay mixing and sieving



Ball clay



Clay slip/Slurry

iv. Product Design and Prototyping



Product ideation and design



Presentation of designs



Prototyping using clay

v. Moulds



One piece of mold made out of plaster of Paris



A second mold made out of plaster of Paris



All 4 pieces of mold made out of plaster of Paris

vi. Casting and Production



Slip Casting in mold



Finishing touches on green ware



Polished Ceramic product

vii. Drying / Kilning



Drying of cast green-ware products



Shuttle Kiln at Kenyatta University
ideal for large products



Kiln at KIRDI



Wood fired kiln at Mukurweini
School of Ceramics

viii. Glazing



Spray glazing process



Glazed toilet product ready for
second firing



Glazing unit at SAJ Ceramics

Final Ceramic Toilet



Branding / Packaging

The product developed was branded “Ngisi”, a name coined from a Samburu name “Ngisipet”, meaning a shovel-like tool used in the Samburu community to dig holes in the ground which are later covered whenever they want to relieve themselves. A wider range of ceramic fittings produced will be branded and packaged under Ngisi Brand.



Ngisipet of the Samburu Community



Brand name and symbol inspired by “Ngisipet”

Findings

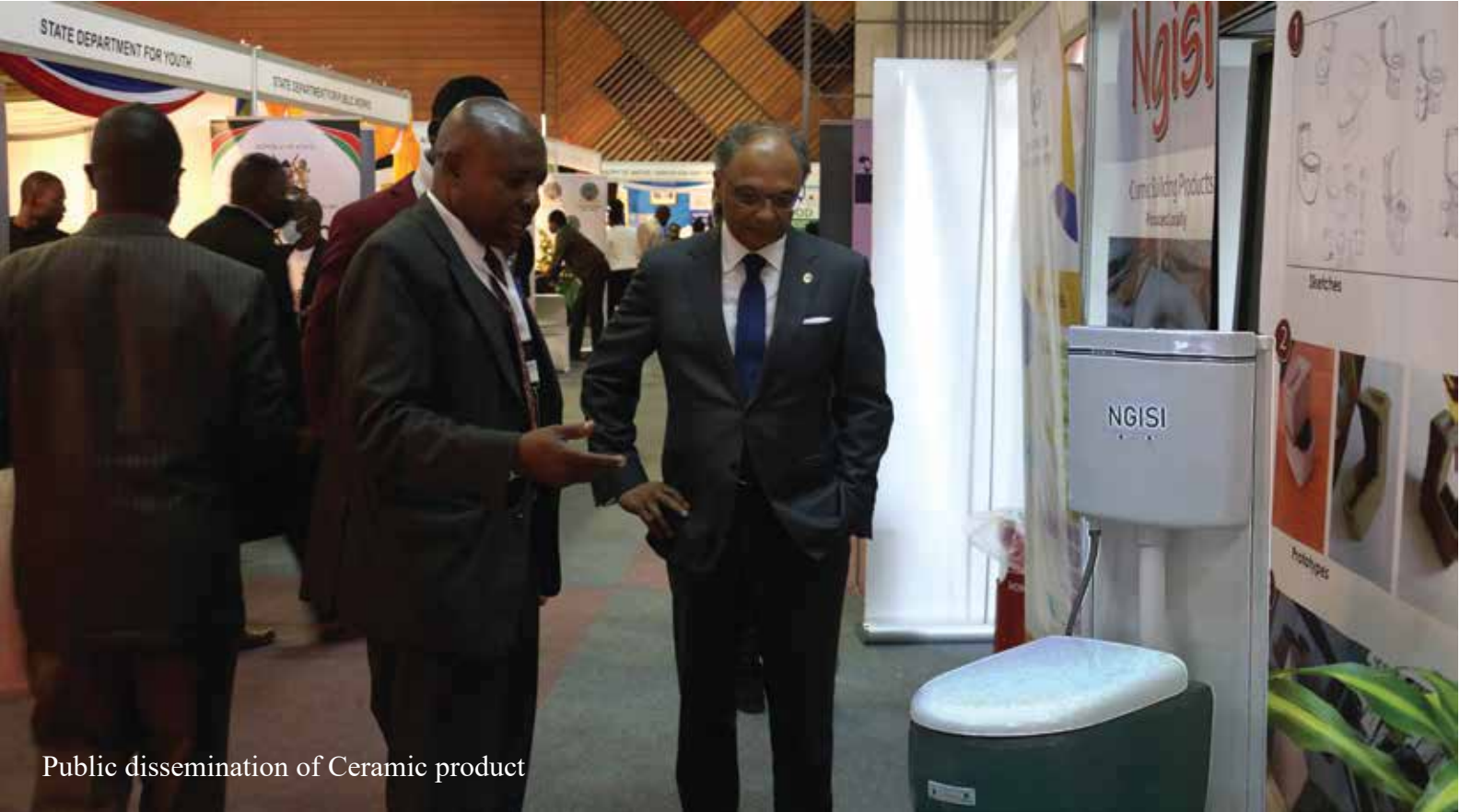
- i. The raw materials used in the manufacture of tiles at SAJ include clay in Makueni, Mukurweini, and Nunguni), sand (from Kalama), feldspar, lime, and dolomite. Additionally, 90% of the glaze that is used is imported from Europe (Spain and Italy) for various reasons such as the lack of equipment for the production of glazes. Mukurweini – Karundu clay deposit has continued to provide raw material to the local ceramic industries for the production of crockery and tiles although it is equally suitable for heavy ceramics production (roofing tiles, bricks, sewage pipes), as well as sanitary ware. Iveti hills clay deposits consist of high-grade Kaolin, of commercial value. The kaolin is not naturally exposed but is overlain by a thin overburden of superficial soils and alluvium ranging between 0.3 – 1 m thick. Both visual and microscopic examinations reveal the mineral composition of the Tulumani kaolin to be quite similar to that occurring at Nuguuni hills. Illite, Kaolin and quartz are the dominant minerals with minor feldspar, calcite and pyrite.
- ii. Raw glazing materials are exported, processed, and then imported back into the country at a high cost. Moreover, the 1-2% sodium silicate/sodium tripolyphosphate that is used to reduce the plasticity of the clay is locally readily available. Although coal, commonly used to fire the kilns is imported, it was observed that it can be found in some deposits locally.
- iii. Incubation for upcoming entrepreneurs interested in ceramics-related industries is provided by KIRDI which also carries out research and training in ceramics and clay technologies offering consultancy services in kiln design and construction. KIRDI also undertakes local clay sampling and screening for appropriate utilization in the production of various products. Some of the materials commonly tested were sourced from Makueni, Mukurweini, and Nandi.
- iv. Kenyatta University has kilns that are able to accommodate large-scale ceramic products with the capacity to fire up to 1200. The university is able to produce glazes from local materials although with limitations on a range of colors. The institution has advanced in research on the firing of ceramic products. The availability of local materials shows an opportunity to widen and commercialize the research and production of these toilets.

Recommendations

- i. Based on field observations and positive laboratory diffraction data achieved, clay deposits in Kenya should be investigated further for their chemical composition (XRF analysis) and physical properties (moisture content, residue % over 80 and 200 mesh sieves, modulus rupture, shrinkage (%), particle size distribution, loss of ignition, etc) to further constrain its properties and uses as a suitable ceramic material.
- ii. The building industry should incorporate 3D printing into the production of building products such as ceramic fittings as well as in the construction of housing. Product development is a major opportunity gap where local and regional researchers and creators can reap the benefits of applying digital fabrication, especially in the production of prototypes, pre-testing, and iterations in a faster and cheaper process through 3D Printing.
- iii. More studies should be carried out to upscale the range of ceramic fittings production and commercialization to lower the cost of housing in Kenya. Areas of interest should be ball clays and minerals with suitable chemical compounds for the production of various ceramic fittings, with consciousness of sustainable energy and the environment.

Conclusions

High potential in Ceramic Industry to support affordable Housing in Kenya was identified. Although clay and glazing materials are locally available in large deposits, more research and investment need to be made into their commercialization. Coal can be mined locally for firing the kilns to supplement gas and electric run kilns. In the effort to exploit clean energy sources. Manufacturing of equipment including kilns with adequate capacity in addition to a reliable source of power supply can be achieved from local training institutions and innovation incubation centers. Adequate technical know-how in the manufacturing process of ceramic materials is necessary and can be achieved. Considering the high level of importation of glazing materials, an opportunity exists for exploring local sources of glazing materials and their value addition to meet industrial standards.



Public dissemination of Ceramic product



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