Appropriate Technology Project

Business Plan for the Implementation of Appropriate Technology Alternative to Brick Firing in Uganda

WIPO

Business Plan for the Implementation of Appropriate Technology Alternative to Brick Firing in Uganda

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National Expert Group for the Bilateral Project on Appropriate Technology for Uganda.

Executive summary

The World Intellectual Property Organization (WIPO) in cooperation with the Government of the Republic of Uganda has implemented the Bilateral Project on Appropriate Technology for Uganda. For the project, the Government of Uganda was represented by the National Expert Group (NEG), chaired by the Registrar General of the Uganda Registration Services Bureau (URSB), with members drawn from different Ministries, Agencies, Departments, Research Institutes and Universities. The NEG was assigned with the responsibility of steering the project implementation at the national level, whereas the Uganda Registration Services Bureau (URSB) was tasked with the role of the focal point to coordinate the project on behalf of Uganda.

The purpose was to support Uganda in the identification, management, administration and utilization of technical and scientific information, with a focus on patent information, and in building national capacity on appropriate technology for development. In particular, the project focused on facilitating the use of patent information as a source of technology or technological solution for addressing the development needs at the community level. Identifying two appropriate technologies to be deployed at the beneficiary community was an important outcome of the project. The patent information search, which was conducted under this bilateral project, has provided an alternative technological solution to fired bricks as a way of preserving the environment. The preparation of the business plans for the identified technologies/technological solutions has been the final stage of the Bilateral Project on Appropriate Technology Uganda with WIPO, which concluded recently.

Thus, this document serves as a business plan for the next project, to be implemented by the Government of Uganda with potential partners and stakeholders, for the adoption and development of alternative technology to fired bricks, which was identified as the result of the afore-mentioned bilateral project.

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Burned bricks are some of the most common construction methodologies used in urban areas. In rural areas, wattle and daub still dominates construction, for the poor in particular. For many people, a house made of burned bricks is accorded higher status than one made of sun-dried mud blocks or through wattle and daub. However, the process of burning clay bricks requires several mature trees for fuel, which leads to deforestation and the attendant negative environmental effects. Therefore, as the construction industry grows, alternative technologies to burned bricks are needed to limit deforestation.

The selected patent technology for brick stabilization was patent CN104844091A, entitled Raw soil building binding material suitable for raw soil building blocks and preparation method of binding material. This is a geopolymer/cementitious materials-based technology where the brick raw materials – soil, active mixed materials comprised of, for example, fly ash, silica fume, slag or kaolin, plant fiber or ultra-light aggregate of glass or polystyrene microbeads and a 1–2 per cent admixture of 0.001–0.004 per cent water retaining agent, 0.5–1.5 per cent activator and 0.5–1.0 per cent enhancer – are mixed with water to form a slurry. The mixture is then molded as desired, dried and solidified, and may be subsequently used as wall or plastering material to replace solid clay sintered bricks.

Compared with other technologies, this process offers the following advantages:

- It produces higher quality, more environmentally friendly products than mud bricks, which require burning.
- The processes for producing compressed earth bricks (CEB) and interlocking stabilized soil blocks (ISSB) require machinery and are potentially more expensive.
- Concrete blocks require a lot of cement.
- Burned bricks are not environmentally friendly.

The fact no machinery is needed means the proposed technology can be easily adopted by people in rural areas. To improve the prospects of the brick technology being more widely accepted and adapted, further research and development (R&D) was required. It was proposed that this be carried out at the School of Engineering, Makerere University.

Economic considerations

Standard size bricks measure 100 mm x 150 mm x 230 mm. With a cement content of 8 per cent, one bag of cement produces 600 bricks at a cement cost of 50 Uganda shillings per brick. Allowing another 50 Uganda shillings for labor and additives means a total production cost of 100 Uganda shillings per brick. For producing these bricks on site, each youth worker will require equipment and tools costing about 100,000 Uganda shillings (about 30 United States dollars based on January 2023 exchange rate).

Specific target community

The target community is Nakawa Vocational Training Institute, a public institute operated and administered by the Uganda Ministry of Education and Sports. It is located off the Kampala-Jinja Road, approximately 5.5 km east of Kampala's central business district. The institution offers several training courses including those in masonry and bricklaying/brick fabrication. The department of building construction is interested in the alternative technology to fired bricks. The project will be an opportunity for the department to examine the bricks technology and establish an eco-san (ecological sanitation) toilet for the institute.

Plan submission

Building projects usually require architectural and structural plans as per Appendix 1. Although some builders in rural areas proceed without plans, it is increasingly necessary to have these due to rapid urbanization. Also, regulatory town councils are constantly being created in growing trading centers. Therefore, the project developers, aided by the local contractors, will submit their plans to the town council or district for approval. In future, this will be especially necessary when schools or health centers are to be built.

The key institutions in implementing the project will be:

- Uganda Registration Services Bureau (URSB), the project manager
- Ministry of Lands, Housing and Urban Development, responsible for policy formulation on land use and housing development
- Ministry of Local Government, responsible for decentralized local governments, including districts, subcounties and parishes
- Kampala district, the host district.

The National Expert Group (NEG)/Uganda Registration Services Bureau (URSB) will be the project's overall authority. Through its projects division, it will be responsible for project management, including payments and accounting. It will liaise with the ministries, research institutions and stakeholders, and recruit the project coordinator, who will be responsible for initiating project activities and ensuring that the beneficiary communities implement them. The project coordinator will be assisted by Nakawa Vocational Training Institute administrators. The project is estimated to last for 12 months and cost 93.8 million Uganda shillings (about 26,000 United States dollars). These funds will be obtained from the Government, stakeholders and the beneficiary community. The proposed financing structure is shown below.

No	*Source*	*Amount (UGX)*	*Percentage*
1	Grant	65,660,000	70
2	Microfinance	14,070,000	15
3	Contribution community	14,070,000	15
	Total	**93,800,000**	**100**
Financial summary			
No.	*Particulars*	*Cost (UGX)*	
1	Technology development	17,000,000	
2	Pre-operating (project management)	61,800,000	
3	Operations and maintenance (piloting)	15,000,000	
	Total	**93,800,000** (US$26,000)	

Source: Author

Project outcomes and impact

The immediate outcomes from this project will be improved sanitation, preserved trees and a reduction in transported building materials. Construction of an eco-san toilet will deliver significant benefits to the institute, including a conserved environment and improved student health.

Conclusions

The technology is appropriate and affordable for low-cost housing in Uganda. It can replace burned bricks, thereby contributing to environmental protection, and is appropriate for rural areas with the potential to create jobs.

Recommendation

It is recommended that the alternative brick technology initially be implemented among the target group. If successful, it can be expanded to other districts.

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Abbreviations and acronyms

BOQs	bill of quantities
CEB	compressed earth bricks
IS	international standards
ISSB	interlocking stabilized soil blocks
KCCA	Kampala Capital City Authority
MOU	memorandum of understanding
NEG	National Expert Group
PPDA	Public Procurement and Disposal of Public Assets Authority
R&D	research and development
UNBS	Uganga National Bureau of Standards
URSB	Uganda Registration Services Bureau

1. Introduction

The World Intellectual Property Organization (WIPO) in cooperation with the Government of the Republic of Uganda has implemented the Bilateral Project on Appropriate Technology for Uganda. For the project, the Government of Uganda was represented by the National Expert Group (NEG), chaired by the Registrar General of the Uganda Registration Services Bureau (URSB), with members drawn from different Ministries, Agencies, Departments, Research Institutes and Universities. The NEG was assigned with the responsibility of steering the project implementation at the national level, whereas the Uganda Registration Services Bureau (URSB) was tasked with the role of the focal point to coordinate the project on behalf of Uganda.

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1.1 Background information

Housing is a basic human right, essential for the well-being of all humanity. Uganda's 1995 constitution, under the general social and economic objectives, guarantees to fulfill the fundamental rights of all Ugandans to social justice and economic development, and to enjoy rights and opportunities and access to clean and safe water, health and decent shelter, among other things. The quality and quantity of Uganda's housing is inadequate in both rural and urban areas. The housing deficit stands at 2.4 million units; 210,000 in urban areas and 1.395 million in rural areas as of 2020.

It is estimated Uganda has about 7.3 million households living in 6.2 million housing units, with an average household size of 4.7 persons. The national occupancy density is estimated at 1.1 household per housing unit, giving a total backlog of 710,000 housing units. There is also an

estimated backlog of 900,000 housing units as a result of substandard houses and structures that were never meant for human habitation.

The annual need for new housing for the country is estimated at 200,000 housing units; 135,000 in rural areas and 65,000 in urban areas, resulting from a population growth of 3.2 per cent and a 5.1 per cent rise in urbanization. The estimated annual construction rate of reasonably good houses is estimated at 40,000 housing units in rural areas and 20,000 in urban areas. This creates a deficit of 140,000 houses nationally, of which 95,000 are in rural areas and 45,000 in urban areas.

1.2 Housing issues and challenges

High poverty levels, as manifested in the rather low levels of household incomes (estimated at 150 US dollars per annum, according to the Uganda National Household Survey 2012/13), has made access to decent housing an elusive dream to the majority of the population, especially those living below the poverty line.

The increasing population has led to high demand for the construction of more residential houses and related basic infrastructure and services – roads, water and sanitation, drainage, energy, schools, health and recreation facilities, workplaces – whose supply are not commensurate with need. Further, the rapid urbanization process, currently standing at about 5.1 per cent per annum, coupled with an incapacity to provide planned and serviced land for housing, has led to the development of slums and informal settlements, which account for about 60 per cent of urban settlements.

There is a shortage or absence of institutional/employer housing in many parts of the country following divesture of government pool/institutional houses and other private sector institutional housing. Most affected are newly created districts where private rental housing is in short supply.

An inadequate supply of affordable building materials has enhanced competition and high prices for the scarce commodities available. Research and development (R&D) in the sector is yet to deliver options for the mass production of affordable building materials.

1.3 Building sector

Buildings are classified on the basis of their purpose. They are designated as residential, commercial or mixed use (both residential and commercial in the same building), industrial, institutional, and other use. Residential buildings include apartments, bungalows and dormitories. Commercial buildings include warehouses, shops, shopping malls, gas stations, markets, pharmacies, offices and supermarkets. Industrial buildings include factories, food mills, sawmills, power plants, bakeries and breweries. Institutional buildings include libraries, colleges, child development centers, primary and secondary schools, institutes, universities, hospitals,

health centers, nursing homes, clinics, police stations, barracks and prisons. Other structures include banks, youth/child centers, museums, court buildings, churches, mosques, temples, shrines, beauty salons, fitness centers and sports clubs.

Before construction, developers obtain four sets of submission forms from the area building inspector of their respective division. They must then submit the completed forms to the inspector, accompanied by four sets of architectural drawings and a sketch of the location plan drawn to a scale of 1:2500. The Kampala Capital City Authority (KCCA) and other bigger municipalities provide applicants with a checklist, which has all the requirements for submitting building plans (see Appendix 1 for the KCCA checklist). The plans are assessed for approval after all the requirements have been met and payment made.

Every year the Uganda Bureau of Statistics (UBOS) receives returns on building plans submitted, approved, deferred or rejected, and occupational permits issued in the country from selected town councils and municipalities. The following data are for calendar years 2014 to 2019. Data were collected from 25 municipalities and 60 town councils in 2014; 25 municipalities and 60 town councils in 2015; 35 municipalities and 90 town councils in 2016; 40 municipalities and 115 town councils in 2017; 39 municipalities and 156 town councils in 2018; and 50 municipalities and 230 town councils in 2019. This shows an increase of 129.4 per cent in coverage in town councils and municipalities since 2014 due to smaller urban centers having been upgraded to town councils or municipalities. Details are shown in tables 1 and 2. During 2019, the majority of building plans submitted were for residential structures (59.1 per cent), followed by commercial structures (28.8 per cent) and institutional structures (3.7 per cent), while other building categories registered less than 2 per cent.

Table 1 Plans submitted from 2015 to 2019

Categories	Plans Submitted from 2015 to 2019				
	2015	2016	2017	2018	2019
Residential	3,845	5,285	8,122	7,488	9,734
Commercial	2,146	3,149	4,207	3,506	4,733
Mixed-use			450	752	827
Industrial	98	113	188	190	213
Institutional	348	466	727	531	611
Others	105	178	257	298	343
Total	**6,542**	**9,191**	**13,951**	**12,765**	**16,461**

Source: Uganda Bureau of Statistics

Table 2 Plans approved from 2015 to 2019

Categories	Plans Approved from 2015 to 2019				
	2015	2016	2017	2018	2019
Residential	3,597	3,758	3,765	5,689	8,534
Commercial	1,680	2,236	2,450	2,907	4,361
Mixed-use			103	527	791
Industrial	88	79	-	124	223
Institutional	238	323	365	391	508
Others	174	132	125	230	265
Total	**5,777**	**6,528**	**6,808**	**9,868**	**14,681**

Source: Uganda Bureau of Statistics

Table 1 and table 2 show that the level of intended construction even in urban areas is well below the actual demand for housing. It must be emphasized that building plans are mostly submitted in urban centers where relevant officers such as planners, surveyors, engineers and building inspectors are employed. In rural areas, people get a sketch from a local contractor, usually a mason, and start building. Most local contractors usually acquire experience on the job. That is why most housing in rural areas is substandard. Also, most rural houses are smaller than is adequate for the family because of constrained budgets.

1.4 Current status of the technology

Once you decide to work with bricks, the next step is figuring out what kind to use in your project. Some types of bricks are built for strength, while others are designed mostly to appeal to the eye. But finding the right one for your needs can be difficult. And, while bricks may seem modest and simple, when deployed properly, they can be glamorous. The section below presents the most commonly used bricks for construction in Uganda.

Mud and wattle

Most rural inhabitants live in thatched huts with mud and wattle walls, but styles of building vary from group to group. One advantage of mud and wattle bricks is that most of the materials are obtainable locally. Also, mud and wattle structures are earthquake resistant due to their flexibility. However, these structures do not last a long time because the poles get damaged by termites.

Mud bricks

In rural areas, soil and water are mixed using hand tools and feet to make a slurry. This is fed into wooden molds to form bricks. The bricks are sun-cured and then fired in a tunnel kiln with firewood as fuel. While these bricks are an upgrade from mud and wattle, they contribute to degradation of the environment.

Compressed earth bricks

A compressed earth block (CEB), also known as a pressed earth block or compressed soil block, is a building material made primarily from damp soil compressed at high pressure to form blocks. There are several advantages to the CEB. It reduces environmental hazards as it is biodegradable and limits deforestation as firewood is not required to produce them. It is also an energy-efficient and eco-friendly choice, requiring only a small amount of stabilizer; 15–20 times less than that of fired bricks.

Earth blocks

Earth blocks can be used immediately after they are compressed in a high-pressure hydraulic ram. However, the blocks shrink slightly as they dry, so they are cured. The Loreto Bay plant has

three compression machines at three production stations. At each station, workers set the newly made blocks on pallets

Interlocking stabilized soil blocks

In East Africa, the manual interlocking stabilized soil block (ISSB) machine is manufactured in Kenya. ISSB blocks arose from compressed earth blocks, using a machine and special molds to produce them. The interlocking profile allows for easy construction without using a lot of mortar. The machine compresses the soil and sand mixture to give stronger products that can be used after a short period of curing in the sun. These products are environmentally friendly because they do not need burning or firing. ISSB blocks are used to construct buildings, latrines, wells, septic tanks and water tanks.

Burned clay bricks

Burned bricks are commonly used in construction in urban areas, whereas in rural areas, wattle and daub varieties still dominate construction, for the poor in particular. For many people, a house made of burned bricks is accorded higher status than one made of sun-dried mud blocks or through wattle and daub.

Concrete blocks

For some time now, house construction in Uganda has relied on fired bricks. However, they have come at a high cost to the environment. It is not clear how many trees have to be felled to produce 10,000 bricks for house construction in Uganda, but such practices have had a devastating effect on the hardwood cover in Uganda and in Africa in general. Since the hardwood required to fire these bricks is becoming increasingly rare, the industry is adopting alternative methods.

Concrete blocks are a mixture of sand, gravel, cement and water, molded together to create a rectangular solid block. The block, which is available in different sizes, typically comes in a smooth finish but can be found in decorative split finishes that many people find more attractive. The concrete blocks that have a high demand in large construction projects come in either solid or hollow forms that are used for different components of a house.

Industrially manufactured bricks

A few factories mine and process clay, using machinery to produce uniform bricks and other building materials. These materials are fired in specialized kilns that commonly use biomass, such as coffee husks. They are more environmentally friendly since they use alternatives to wood. The bricks and other materials produced by these factories are far superior to the local burned bricks and preferred by many, especially in urban centers.

1.5 Advantages and disadvantages of each technology

The pros and cons of each type of brick is outlined in the table below.

Table 3 **Advantages and disadvantages of each technology**

Advantages of each technology		
ISSB 1. Main raw material is soil with an addition of cement 2. Made with a manually operated block press 3. No firing required 4. There is no wastage in production 5. Fast to build with, and unskilled people can quickly learn how to build with the blocks	*Concrete blocks* 1. Main raw material is sand and sometimes gravel with an addition of cement. 2. Requires only a manual hand mold 3. No firing required	*Burned bricks* 1. Main raw material is clay soil and firewood 2. Only equipment required is a simple hand mold 3. Traditional skills are available in many rural settings
Disadvantages of each technology		
ISSB 1. Requires specialized design considerations and columns at corners and around openings	*Concrete blocks* 1. Consumes a lot of cement 2. Requires sand and gravel, some rare materials in some states of South Sudan 3. Requires skilled people to build with them 4. Compared to ISSB, concrete blocks take a longer time to build	*Burned bricks* 1. Traditional brickmaking has 40–50% wastage 2. Consumes a lot of firewood to burn the bricks, causing deforestation 3. Requires skilled people to build with them 4. Construction process takes a long time as the bricks are small, therefore costing more in terms of labor 5. Requires a minimum of two months to have them ready for construction

Source: Author

2. Description of the proposed technology

The selected patent technology for brick stabilization was patent identifier CN104844091A, entitled Raw soil building binding material suitable for raw soil building blocks and preparation method of binding material. This is a geopolymer/cementitious materials-based technology where the brick raw materials – raw soil, active mixed materials comprised of, for example, fly ash, silica fume, slag or kaolin, plant fiber or ultra-light aggregate of glass or polystyrene microbeads and a 1–2 per cent admixture of 0.001–0.004 per cent water retaining agent, 0.5–1.5 per cent activator and 0.5–1.0 per cent enhancer – are mixed with water to form a slurry. The mixture is then molded as desired, dried and solidified, and may then be subsequently used as wall or plastering material to replace solid clay sintered bricks.

Biocementation has the potential to be well suited to brick production in developing and Least Develped Countries (LDCs). Key factors for increased take-up will most likely be affordability of materials and ensuring the process is simple compared with existing practices. The chemical composition of locally sourced raw materials will determine brick strength and durability. Some research and development for technology optimization may be required. Partnering with university researchers would be cost-effective.

The following is an abstract from Espacenet, the free online service for searching patents and patent applications:

> 'The invention provides a raw soil building binding material suitable for raw soil building blocks and a preparation method of the binding material. The invention belongs to the technical field of building materials, and provides the raw soil building binding material suitable for the raw soil building blocks and the preparation method of the binding material, wherein the preparation method is capable of improving the physical and mechanical properties, the crack resistance and the durability of the raw soil material, and has characteristics of local materials, simple and easy operations, economic efficiency and environmental protection; the raw soil building binding material comprises such components as 80-88% of raw soil, 5-10% of cement, 5-10% of active mixed material, 1-2% of ultralight aggregate and 1-2% of admixture; the raw soil is pretreated and blended to prepare a mixture, and finally, the slurry raw soil plastering binding material can be obtained; the raw soil building binding material is energy-saving, environmental friendly, recyclable, good in water-retaining property, high in bonding strength, good in crack resistance, low in cost, convenient in material use, economical and practicable, simple in production process, low in equipment investment, simple and convenient in operation, and convenient to implement and popularize; besides, the color and the texture of the traditional saw soil material also are kept.'

2.1 Comparison of the proposed technology with current brick technology

- Proposed technology will produce better quality bricks and be more environmentally friendly than that used for mud bricks, which require burning.
- Compressed earth bricks require machinery in their production, and hence, might be more expensive than the proposed technology.

- ISSB blocks require machinery, while the proposed technology does not.
- Concrete blocks require a lot of cement compared with the proposed technology.
- Burned bricks are not environmentally friendly.

The fact no machinery is needed means the proposed technology can easily be adopted by people in rural areas.

3. Possible target groups/communities

The possible target groups/communities under this project are described below.

Table 4 **Possible target communities for brickmaking technology**

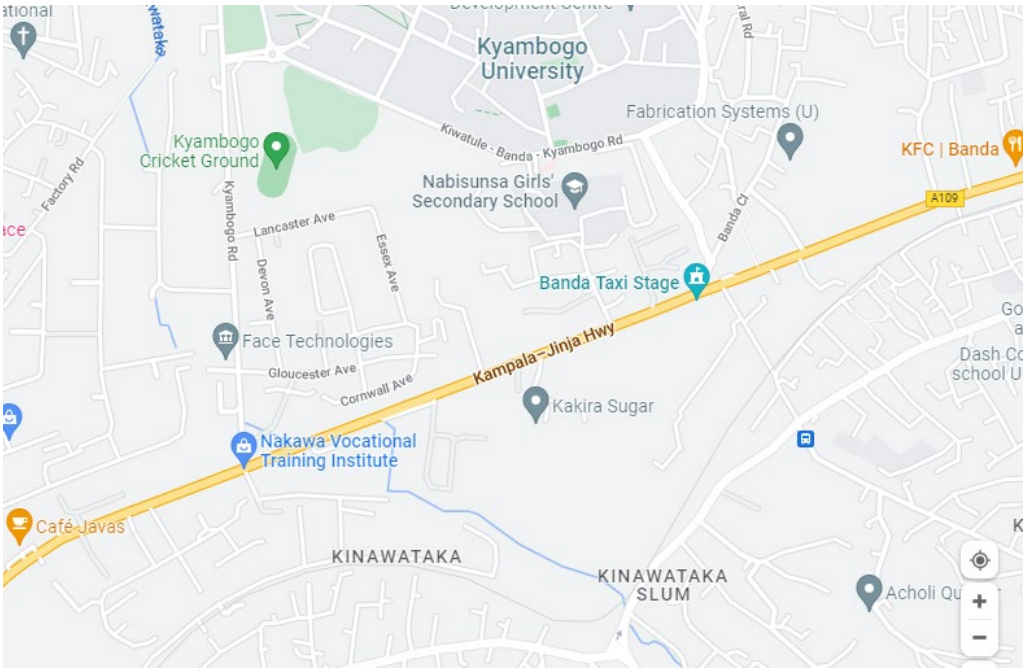
S/N	*Target group*	*Purpose*	*Current situation*
1	Rural population	Rural majority need dwellings	Housing is of poor quality with a deficit of 1.6 million housing units It is a challenge to supply affordable housing
2	Youth groups and local contractors	To supply building materials for local contractors	Not organized and contractors not well skilled
3	Education sector	Bricks to build classrooms for primary and secondary school, community colleges, teachers' quarters, latrines, offices and water tanks	There is a shortage of classrooms, staff houses and sanitation facilities
4	Health sector	Bricks can be used to construct staff quarters, toilets, clinics, offices, medical stores and water tanks	Both private and public health centers have insufficient patient wards, staff housing, treatment areas, sanitary facilities and water storage tanks
5	Real estate developers	Buy land, look for loans and put buildings up for sale	Have access to finance and deal with clients (building houses) directly Acquire machines and appropriate brickmaking technologies and facilities
6	Landlords in urban areas	Put up commercial or mixed-use buildings	The major developers in urban areas but face mortgage finance challenges
7	Police	Need housing units and offices	Severe lack of these facilities such that they reside in uni-ports
8	Prisons	An expansion of cells and staff housing is needed	Overcrowding due to inadequate space
9	Local government	Need office space	Many local governments (districts, municipalities, town councils, cities) have been designated but have nowhere to operate from, hence the need to construct

Source: Author

3.1 Specific target community

To pilot the technology, it is proposed to start with Nakawa Vocational Training Institute. This is a public institute operated and administered by the Uganda Ministry of Education and Sports. It is located off the Kampala-Jinja Road, approximately 5.5 km east of Kampala's central business district. The institution offers several training courses, including those in masonry and bricklaying/brick fabrication. The department of building construction is interested in the alternative technology to fired bricks. The project will be an opportunity for the department to examine the bricks technology and establish an eco-san (ecological sanitation) toilet for the institute. The department is willing to participate in the implementation of the project and to contribute resources. Table 9 details the steps needed to mobilize the community.

Figure 1 **Map of Nakawa Vocational Training Institute and surroundings**



Source: Google Maps.

The technology will meet the following needs:

- provide good use of locally available soils as a quality building material;
- construct affordable low-cost facilities for the institute;
- create jobs for local youths and contractors; and
- increase the possibility of other institute structures.

3.2 Technology development

To improve the chances of the brick technology being more widely accepted and adopted, further research and development is needed. It is proposed this be carried out at the School of Engineering, Makerere University, and include the following:

- produce prototypes using various mixes of soil, cement and other additives as per patent;
- test prototypes for properties and performance;
- recommend an optimum mix of ingredients;
- determine commercial cost of producing the brick;
- determine cost of erecting 1 m^2 of wall using the brick technology; and
- produce a report.

3.3 Production

3.3.1 Equipment

Each group member should have

- sieve, measuring 1 m^2
- garden hoe
- pickaxe
- machete
- spade
- two wooden molds

This will enable each group member to work independently and be paid according to the number of bricks they produce.

3.3.2 Production process

The production process will be as follows:

1. clear site of grass, shrubs and other vegetation;
2. excavate the soil;
3. sift the soil;
4. add water, cement and other additive;
5. mix thoroughly;
6. fill the mold;
7. cure in sun; and
8. use in construction after curing.

3.3.3 Indicative costing of bricks

For bricks of standard size (100 mm x 10 mm x 230 mm) and a cement content of 8 per cent, a bag of cement produces 600 bricks at a cement cost of 50 Ugandan shillings per brick.

Allowing a further 50 shillings for labor and additives gives a total production cost of 100 shillings per brick. Local contractors and youths can then sell each brick at 150–200 shillings. This compares favorably with burned clay bricks, which sell for 300 shillings at the production site. In addition, there are handling and transport costs in getting them to the construction site, which could add another 100 shillings to the sale price.

4. Policy, legal and institutional framework

4.1 Legal framework

The policy and legal framework for the housing sector is inadequate and scattered under different instruments, which makes it hard for the sector to effectively implement them. Policies relating to housing development include those on decentralization, health, national land use, management of the environment, water and gender, among others. The legal framework regulating the housing sector includes:

- Uganda's 1995 constitution.
- Land Act (1998), Cap. 227.
- Mortgage Act (2009).
- Registration of Titles Act (1964), Cap. 230.
- Land Acquisition Act (1965), Cap. 226.
- Survey Act (1939), Cap. 232.
- Condominium Property Act (2001).
- Cooperative Societies Act (1991), Cap. 112.
- Building Societies Act (1955), Cap. 108.
- Physical Planning Act (2010).
- Architects Registration Act (2000), Cap. 269.
- Surveyors Registration Act (1974), Cap. 275.

Other laws include: the Rent Restriction Act (2000), Cap. 231; Local Government Act (1997), Cap. 243; National Environmental Act (2019), Cap. 153; Public Health Act (1935), Cap. 281; Local Governments (Rating) Act (2005); and the Engineers Registration Act (1969).

Construction of buildings in Uganda is regulated by various laws. To erect a building, be it commercial or residential, a developer must be aware of requirements and conditions imposed by different laws. These include the Building Control Act (2013), Physical Planning Act (2010), National Environment Act (2019), Land Act (1998) and the Occupational Safety and Health Act (2006).

4.2 Policies

1. Establish a mechanism to coordinate, develop, promote and disseminate information and research on affordable and sustainable use of building materials and appropriate construction technologies that are cost-effective, environmentally friendly and culturally acceptable. Strategies should
   - promote use of local materials and appropriate construction technologies that are affordable/readily available;

- undertake public awareness campaigns on available conventional and alternative building materials;
- research production and use of local building materials and other technologies;
- establish depository and mechanism for disseminating housing-related research findings;
- develop building materials data bank showing available materials, their specifications, cost and the applicable tax, among other things;
- establish research center to harness, witness, document and demonstrate use, and disseminate information on existing and new building materials/technologies;
- strengthen the administration, regulatory and institutional framework to ensure certification, registration and control of professional practices;
- support self-help/owner management techniques for small-scale production, and the industrialized mass production of houses for large-scale schemes;
- promote use of innovative construction technologies that deliver energy efficiency, water harvesting and environmental preservation; and
- promote small-scale enterprises to engage in the production and application of researched building materials and technologies.

2. Develop human resources and build capacity. Housing development requires a range of labor, including skilled, semiskilled and unskilled. Skilled labor includes disciplines such as engineering, architecture, surveying, planning, financing and management. The semiskilled category includes technicians and artisans while the unskilled comprises mainly casual laborers. Policy issues include:
   - limited number of housing professionals in the country;
   - uneven distribution of professionals, who are mainly in urban areas;
   - inadequate funding for tertiary and vocational training institutions leading to limited intake of students;
   - stringent registration procedures for surveyors, engineers and architects, which reduces their availability and creates an artificial shortage; and
   - absence of dedicated housing departments in local government to provide assistance/guidance for housing development.

4.3 Building regulations in Uganda

Building construction in Uganda is regulated by various laws. To erect a commercial or residential building, there are various requirements and conditions imposed by different laws.

The laws include: the Building Control Act (2013), Physical Planning Act (2010), National Environmental Act (2019), the Land Act (1998) and the Occupational Safety and Health Act (2006). There are also regulations and codes made under the Building Control Act. These are: the Building Control Regulations (2020), National Building (Building Standards Code) (2019), Building

Control (Accessibility Standards for Persons with Disabilities) Code (2019), Building Control Regulations (2020) and the National Building (Standards for Electrical Installations in Buildings) Code (2019).

4.4 Approvals

To start a building project, a developer will usually need architectural and structural plans as per Appendix 1. Although builders in rural areas do proceed without plans, it is increasingly necessary to have them because of rapid urbanization. Also, regulatory town councils are constantly being created in growing trading centers. Therefore, the developers, aided by the local contractors, will submit their plans to the town council or district for approval. In future, this will be especially necessary when schools or health centers are to be built.

4.5 Quality of building materials

The experience of the contractor can be supplemented by testing samples at the Uganda National Bureau of Standards (UNBS) or the materials testing and research laboratory at the Ministry of Works and Transport. Products such as cement should have a UNBS Q (quality) mark.

5. Implementing team

A team will be necessary for implementing the technology, as outlined below.

5.1 Institutions

- Uganda Registration Services Bureau (URSB).
- Ministry of Lands, Housing and Urban Development, responsible for policy formulation on land use and housing development.
- Ministry of Local Government, responsible for decentralized local governments including districts, subcounties and parishes.
- Kampala district, host district.

5.2 Enterprises

These include the following:

- hardware shops;
- building contractors; and
- transport.

5.3 Experts

The project will need various experts:

- Architects
- Engineers
- Surveyors
- Masons
- Accountants

5.4 Communities

- Wakiso youth groups.
- Wakiso local contractors.
- Nakawa Vocational Training Institute.

6. Stakeholders

The stakeholders listed below can be contacted for various forms of assistance, especially financial and/or technical assistance. The stakeholder analysis is given in table 5 for further guidance.

Table 5 **Stakeholder analysis for alternative brick technology**

S/N	*Name of stakeholder*	*Role of stakeholder*	*Stakeholder influence on Appropriate Technology Project (high, medium, low)*	*Interest in the Appropriate Technology Project (high, medium, low)*
1	Ministry of Lands, Housing and Urban Development	Responsible for formulating policy on land use and housing development	High	High
2	Ministry of Local Government	Responsible for decentralized local governments including, districts, subcounties and parishes	Medium	Medium
3	Ministry of Finance, Planning and Economic Development	Government coordinating agency for donor funding	High	High
4	UN Habitat	Promotes transformative change in cities and human settlements through knowledge, policy advice, technical assistance and collaborative action to leave no one and no place behind	High	High
5	Makerere University, School of Engineering	R&D and innovations in building materials and sustainable construction technologies	High	High
6	Habitat for Humanity Uganda	Builds affordable housing in Uganda and operates a housing microfinance program	High	High
7	Housing Finance Bank	Leading lender of housing finance	High	High
8	Uganda Cooperative Alliance	Implementing the housing cooperative development	High	High
9	Development Finance Company of Uganda (DFCU) Bank	One of the leading lenders for housing	High	Medium
10	National Social Security Fund (NSSF)	Provides wholesale finance to banks for on-lending	High	Medium

11	Centre for Affordable Housing Financing Africa	Independent think tank working to support and grow housing markets in Africa for increased affordability	Medium	Medium
12	Shelter Afrique	Pan-African finance institution that exclusively supports the project and which seeks to mobilize low-income communities into housing cooperatives.	High	High
13	Microfinance Support Centre	Government of Uganda agency that provides microfinance to other microfinance institutions and SACCOs for on-lending	High	Medium
14	National Housing and Construction Company	Real estate developer	Medium	Medium
15	Uganda National Association of Building and Civil Engineering Contractors (UNABCEC)	Advocacy body for the construction industry	Medium	Medium
16	Engineers Registration Board (ERB)	Legal body for regulating the engineering profession	Medium	Medium
17	Uganda Institution of Professional Engineers	Professional body for engineers	High	High
18	Architects Registration Board Uganda	Legal board for regulating the architecture profession	Medium	Medium
19	Institution of Surveyors of Uganda	Professional board for surveyors	Medium	Medium
20	NBS Housing Baraza	Annual media event on housing	Medium	Medium
21	Uganda National Bureau of Standards (UNBS)	Board responsible for drafting and enforcing standards in Uganda	High	High
22	Material research laboratory, Ministry of Works and Transport	R&D in building materials	High	High

Source: Author

7. Governance and management structure

This includes decision-making, authority and responsibility for implementing the business plan, reporting, monitoring and evaluation. The key players are outlined below.

7.1 National Expert Group-Uganda Registration Services Bureau

The National Expert Group (NEG)-Uganda Registration Services Bureau (URSB) will be the overall project authority. Through the projects division, they will be responsible for project management, including payments and accounting. They will liaise with ministries, research institutions and stakeholders, and recruit the project coordinator, who will be responsible for initiating project activities and ensuring the beneficiary communities implement them.

7.2 Project coordinator

The project coordinator will

- identify local contractors to join the project;
- introduce the technology to new recruits;
- conduct training on preparing the raw soil and additives to make the bricks;
- train local contractors on how to build using the bricks; and
- monitor the project and report to URSB.

A draft job description is given in Appendix 2.

7.3 Wakiso Youth Development Association Chair

This person will be elected by the members and tasked with the following:

- hire office space where the association will have contact point;
- liaise with project coordinator on project implementation; and
- receive information on construction jobs.

7.4 Local coordinator

The local coordinator person will

- report to the project coordinator on progress;
- be responsible for marketing and securing construction contracts;
- supervise the youth in making bricks; and
- liaise with other local contractors on marketing and construction activities.

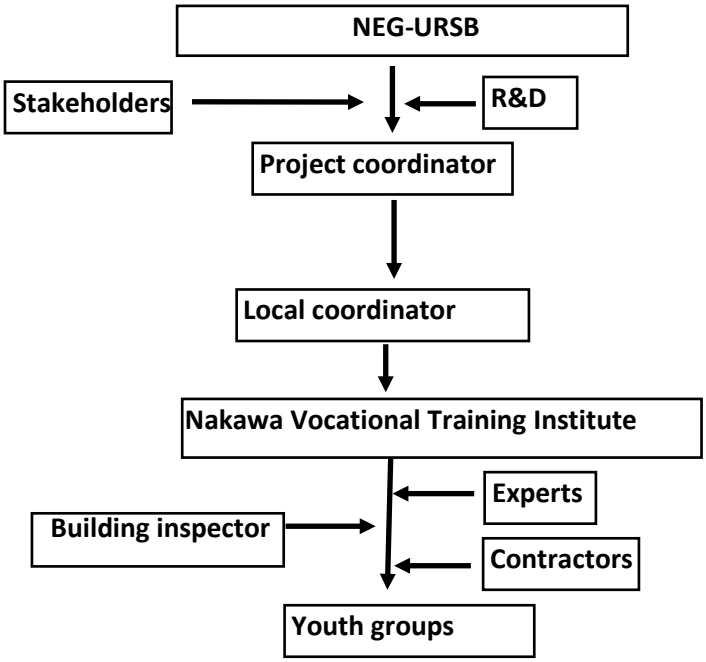
7.5 Youth groups

Youths will be responsible for making bricks according to the technology and do the following:

- provide labor during construction;
- elect a chairperson from their group;
- join savings and credit cooperative organizations (SACCOs); and
- make approvals at annual general meeting.

The proposed organization structure is shown in figure 2.

Figure 2 **Proposed governance structure for the bricks technology project**



Source: Author

7.6 Job description for project coordinator

The draft job description for the project coordinator role is as follows. In order to be able to successfully accomplish the above tasks, the project coordinator for the bricks technology project should have:

- Bachelor's degree in Business Administration/Economics/Engineering/Social Science/Natural Resources, preferably with a focus on water systems from a recognized/reputed university.
- At least five years of relevant working experience on projects, preferably in Uganda, with either a multi- or bilateral donor organization, or construction firm,

or other private sector players, with responsibility for infrastructure projects, preferably in the building sector.

- Strong problem-solving and analytical capacity, and ability to prioritize activities, identify relevant issues and trade offs, and provide appropriate recommendations.
- Excellent oral and written communication skills in English, as well as strong presentation and communication skills to a wide range of audiences.
- Demonstrated ability to interface effectively and collaborate and communicate with different clients and partners, from the public and the private sector, as well as demonstrate intercultural competence.
- Demonstrated ability to work flexibly on a range of assignments, adjust to changes in schedule and priorities, and juggle concurrent tasks effectively and efficiently.

8. Implementation steps and schedule

The proposed implementation plan is designed to facilitate a participatory and consultative approach that involves stakeholders at different stages. The steps are grouped into the following three phases: planning and selection of a manager; pre-operations and team mobilization; and operations and commissioning.

The activities in each phase are described in the sections that follow. The project is estimated to last for 12 months. The implementation steps and schedule are summarized in table 6.

Table 6 **Project implementation schedule**

S/N	*Activity*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*Responsibility*
Phase I: Planning and selection of a manager														
1	Research and development													College of Engineering, Design, Art and Technology, Makerere University
2	Recruit project coordinator													NEG
Phase II: Pre-operations and team mobilization														
3	Community mobilization													Consultant and NEG
4	Resource mobilization													Project coordinator/NEG
5	Recruit experts (engineers, architects)													Project coordinator/community
6	Recruit contractors													Project coordinator/ community
Phase III: Operations and commissioning														
7	Construction works													Contractors
8	Commissioning													NEG/URSB/ Community
9	Operations and maintenance													Project coordinator/ community/contractors
10	Monitoring and evaluation													Project coordinator/district engineer

Source: Author

8.1 Phase I: planning and selection of a manager

In this phase, the NEG should devise strategies to do the following:

1. Mobilize researchers from Makerere University School of Engineering to optimize mixing ratios for the best performing bricks. This technology should be suitable for the communities in terms of affordability, the availability of materials, and skills required.
2. Recruit a project coordinator.

The following is a detailed description of each step.

Step 1: Research and development

The research and development (R&D) team should be able to do the following:

- duplicate the mixing ratios of the bricks in approximated ranges: soils 80–90 per cent of brick composition. Other additives are 4–10 per cent cement (binding), 4-10 per cent lime (stabilizer), and 0.2–1 per cent sawdust (plant fiber);
- test compressive strength for bricks;
- perform impact and shear tests;
- develop the bricks with specifications that comply with American Society of Testing and Materials (IS 1077, IS 2180, ASTM C62, ASTM C216), and the Canadian Standards Association (CSA, A288); and
- recommend main components of the structure (building) suitable for testing the applicability of these bricks.

The research team should also provide the following: engineering designs, manufacturing procedures, installation procedures, prototype, brick strength results, the cost of each brick and any other information that might contribute to the success of this project. Table 7 below provides a detailed action plan for this goal.

Table 7 **Research and development action plan**

Phase I: Planning and selection of a manager					
Goal 1: Development of appropriate brickmaking technology					
Strategies: Use university for R&D					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Appoint a consultant	Month 1	NEG	NEG time, email	Name and contacts for consultant	
Provide terms of reference	Month 1	NEG	Appropriate bricks patent documents, NEG time	Emailed documents	
Conduct research on brickmaking (mixing ratio for materials, procedures, applications, standards, etc.) Build prototype Analysis of results	Month 1 to Month 3	Consultant	Research funds, equipment, materials, time	Prototypes, research results and reports	
Presentation of results	Month 3	Consultant	Computer Stationery Internet	Research report	
Approval of results	Month 3	NEG	Computer	Shared reports	

Source: Author

Step 2: Project coordinator

The coordinator will be responsible for implementing the project on behalf of the NEG. The consultant will have written a job description for the project coordinator role as it is provided in part two of this business plan. The NEG-URSB will advertise the job. Interviews and other recruitment activities will be carried out to identify the right candidate. Table 8 details the recruitment steps.

Table 8 **Job advertisement action plan**

Phase I: Planning and selection of a manager					
Goal 1: Recruit project coordinator					
Strategies: Advertise job in newspapers					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Draft an advert	Month 1	NEG	NEG time, computer	Advert document	
Publish the advert	Month 1	NEG	Advert fee, NEG time	Advert in newspapers, receipt of CVs	
Appoint project coordinator	Month 1	NEG	NEG time	Interviews, terms of reference, appointment letter	
Allocate office/space	Month 1	NEG	NEG time, computer and equipment	Work space	

Source: Author

8.2 Phase II: pre-operations and team mobilization

Step 3: Community mobilization

The consultant will have identified a potential project community. The NEG team, with the help of the project coordinator, will mobilize this community to participate in the implementation. The project coordinator will use all possible means (brochures, phone calls, emails and meetings) to reach the target community. The project coordinator should be able to elaborate the purpose of the project, and the role to be played by those involved, along with their expectations. The project coordinator should have covering letters from NEG-URSB that the communities can easily access. The project coordinator to arrange a memorandum of understanding (MOU) with the community to ease communication. The target community is Nakawa Vocational Training Institute, a public institute operated and administered by the Uganda Ministry of Education and Sports. It is located off the Kampala-Jinja Road, approximately 5.5 km east of Kampala's central business district. The institution offers several training courses including those in masonry and bricklaying/brick fabrication. The department of building construction is interested in the alternative technology to fired bricks study. The project will be an opportunity for the department to examine the bricks technology and establish an eco-san (ecological sanitation) toilet for the institute. The department is willing to participate in the implementation of the project and to contribute resources. Table 9 details the steps for mobilizing the community.

Table 9 **Community mobilization action plan**

Phase II: Pre-operations and team mobilization					
Goal 1: Community mobilization					
Strategies: Network with a community school					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Approach target school	Month 2	Project coordinator	Time/calls/ emails, travel funds, documents	Date for meeting	
Discuss terms of reference	Month 2	Project coordinator/ institute officials	Time, travel funds, documents	Terms and conditions of collaboration	
Draft MOU	Month 2	Project coordinator/ school officials	Time, stationery, Internet	Signed MOU	
Draft common workplan	Month 2	Project coordinator/ school officials	Time, stationery, Internet	Workplan printed	

Source: Author

Step 4: Resource mobilization

The URSB projects office will apply to the Government, through the Ministry of Finance, Planning and Economic Development, for funding from the basket of development finance. In addition, the project coordinator will consult with stakeholders during a meeting on project funding. The project coordinator will consult the community to determine their potential contribution to the project. The project coordinator will contact financial institutions to seek credit finance for participating communities. The target communities will also be requested to make cash and in-kind contributions to show their commitment to the project. Table 10 details the steps for mobilizing resources.

Table 10 **Resource mobilization action plan**

Phase II: Pre-operations and team mobilization					
Goal 1: Fundraise UGX 100,000,000					
Strategies: Organizations and community institute contribution					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Identify possible funder (Ministry of Finance, Planning	Month 2	Project coordinator/ NEG	Time, calls, travel funds, documents, Internet	List of confirmed funds	

and Economic Development, Ministry of Lands, Housing and Urban Development, UN Habitat, and Habitat for Humanity Uganda)					
Present a proposal	Month 2 to month 4	Project coordinator/ NEG	Time, calls, travel funds, documents Internet	The sent proposal document	
Sign agreement	Month 4 to month 6	Project coordinator/ NEG/funding organization	Time, stationery	Copy of agreement	
Present progress reports	Month 7 to month 10	Project coordinator/ NEG	Time, travel funds, documents Internet	Progress report	
Present accountabilities and completion reports	Month 10	Project coordinator/ NEG	Time, travel funds, documents, Internet	Accountabilities and reports	

Source: Author

Step 5: Recruitment of experts (engineers and architects)

The project coordinator formulates terms of reference for the required experts. They will be required to prepare architectural plans and a bill of quantities (BOQs), and to supervise the proposed construction works. The project coordinator will advertise the consultancy job and, in consultation with the community, award the job to the best qualified. Architectural and structural plans will be prepared by the experts and submitted to the district authorities for approval, as outlined in Appendix 1. The building inspector will visit the sites during construction to ensure that the plans are being followed. Upon completion, an occupancy permit will be issued to the owner to enable use of the buildings. Table 11 details the steps for recruiting the architect.

Table 11 **Recruitment of the architect and preparation of architectural plans**

Phase II: Pre-operations and team mobilization					
Goal 1: Recruit architect					
Strategies: Tender advert publication					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Tender advert preparation	Month 6	Project coordinator/ NEG/community user	Time, funds, documents	Tender in papers	
Select best evaluated architect	Month 6	Project coordinator/ NEG/community user	Time, documents	The company details	
Preparation of architectural plans, BOQs and approval of the plans	Month 7	Architect/ project coordinator/ community user	Time, funds, stationery	Designs and drawings	

Source: Author

Step 6: Recruitment of the contractors

The project coordinator will formulate terms of reference for the required experts. The coordinator, together with the community procurement team, will organize the procurement of contractors according to Uganda's Public Procurement and Disposal of Assets Regulations, 2014 (PPDA Contracts-regs-2014). In consultation with the community, jobs will be awarded to the best qualified. The contractors will then purchase and return the BOQs. Contractors should have appropriate skills, such as in brickmaking (using methods based on the research done by the Makerere researchers), laying foundations, walling, roofing, installing windows and doors, and dealing with communities. The experts and the community will evaluate the bids and recommend who the contracts should be awarded to. Contracts are then signed by the contractor and the community. The youths will move to the site, excavate soil and make the mixtures according to the research and development recommendations. They will then make the quantity of bricks required by the BOQs. Next, contractors move to the site. Construction is executed using the already made bricks and other local materials, with the expert supervising the work. On completion, the site is handed over for commissioning. Table 12 details the steps for contractor recruitment.

Table 12 **Publication of the tender action plan**

Phase II: Pre-operations and team mobilization					
Goal 1: Recruit contractor					
Strategies: Tender advert publication					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Tender advert preparation	Month 7	Project coordinator/ NEG/community user	Time, funds, documents	Tender papers	
Select best evaluated bidder	Month 7	Project coordinator/ NEG/community user	Time, documents	The company details	

Source: Author

8.3 Phase III: operations and commissioning

This phase involves the following activities: brickmaking and construction of the eco-san toilet, commissioning, operations and maintenance, and monitoring and evaluation. These activities are explained in the following sections.

Step 7: Construction of the eco-san toilet

In this phase, contractors move to the site and set up as per the BOQ's. Installation is executed: brickmaking, laying of foundations, brick assembly, roofing, finishing. It is anticipated there will be no plaster finishing in order that the application of the newly made bricks be fully appreciated. The project coordinator supervises the work. Progress reports will be submitted to the management team. The contractor trains the users on operations and maintenance. On completion, the site is handed over for commissioning. Table 13 details the steps involved in the construction stage.

Table 13 **Installation of the system action plan**

Phase III: Operations and commissioning					
Goal 1: Construction of the eco-san toilet					
Strategies: Contractor to construct the building					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Procure materials	Month 8	Contractor/project coordinator/ NEG/community sser	Time, funds, labor, trucks	Materials, tools, equipment	
Site establishment	Month 8	Contractor/project coordinator/ NEG/community user	Time, funds, labor, trucks	Storage facilities, local suppliers, labor	
Construction works (brickmaking, laying foundations, walling, roofing, finishing and also tiling the floor)	Month 8 and month 9	Contractor/project coordinator/ NEG/community user	Time, funds, labor, trucks, tools	Structure	
Completion report	Month 10	Contractor	Time documents	Reports	

Source: Author

Step 8: Commissioning

Upon completion of the building's construction, and also submission of the implementation documents – progress reports, invoices, training reports if any – the implementation committee will organize the commissioning of the project. This commissioning is done by the NEG, URSB, district officials and other dignitaries. The project coordinator and community team will plan and organize the project commissioning ceremony, including sending invitation cards to participants. Table 14 details the project commissioning steps.

Table 14 **Project commissioning action plan**

Phase III: Operations and commissioning					
Goal 1: Project commissioning					
Strategies: Celebrate the day with stakeholders with a newspaper article					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Plan handover ceremony	Month 10	Contractor/project coordinator/ NEG/community user	Time, stationery	Celebration plan	
Invite stakeholders	Month 10	Project coordinator/ NEG	Time, brochures, travel, calls	Invitation cards printed and delivered	
Procure ceremony materials	Month 10	Project coordinator/ NEG	Refreshments, food and public communication system	Materials at the site	
Celebrate the day	Month 10	Contractor/project coordinator/NEG/ community user	Time, funds, materials	People sharing ideas, speeches	
Handover	Month 10	Contractor/project coordinator/NEG/ community user	Time, reports, people	Reports	
Newspaper coverage	Month 10	Project coordinator/ NEG/newsletter writers	Article, funds	Article in papers	

Source: Author

Step 9: Maintenance, monitoring and evaluation

Routine maintenance involves cleaning the building and keeping the surrounds tidy. The user should be able to provide monthly reports to the coordinator about the constructed building. The district civil engineer will monitor the performance of the building every six months and report to the NEG/URSB. Table 15 details the monitoring and evaluation steps.

Table 15 **Monitoring and evaluation action plan**

Phase III: Operations and commissioning					
Goal 1: Maintenance, monitoring and evaluation					
Strategies: Reports from the community user					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Record daily	Months 10, 11 and 12	Community user	Time, book	Records in book	
Clean the building	Months 10, 11 and 12	Contractor/ community user	Tools, labor	Cleaned building	
Report leakages and any cracks	Months 10, 11 and 12	Community user	Time, water	Reports	
Monthly reports	Months 10, 11 and 12	Community user	Time, email, book	Reports	

Source: Author

8.4 Accounting and auditing

Although operating under URSB, the project will have separate bank accounts and account books. Financial reports will be made to the NEG on a quarterly basis. The project will be audited according to Government of Uganda laws and guidelines (National Audit Act, 2008), and the audited accounts will also be sent to the funding agencies.

9. Expected costs and required resources

The approximated budget for executing this project is 194,220,000 Ugandan shillings. The budget is dependent on the activities, which are grouped in phases. The main costs involve the mobilization of project resources, paying the project coordinator and constructing the building. The expected costs are further divided into planning, pre-operation and operation.

9.1 Technology development (research and development) costs

Technology development costs include consultancy fees, materials for prototyping and the labor expenses to be managed by the research consultant. Funds for research and development will be used to study and optimize the technology. Table 16 shows the expected costs during the development of the technology.

Table 16 **Planning costs**

S/N	*Particulars/activity*	*Quantity*	*Rate (UGX)*	*Amount (UGX)*	*Justification*
1	Consultancy fee	1	5,000,000	5,000,000	Financial facilitation to the consultant
2	Material costs (prototypes during research)	1	5,000,000	5,000,000	Materials to test the technology and draw conclusions
3	Lab expenses	1	7,000,000	7,000,000	Testing the quality of the alternative bricks
	Total			**17,000,000**	

Source: Author

9.2 Pre-operation costs

The pre-operation costs are incurred in setting the grounds for implementing the project; mobilizing resources and recruiting contractors, for example. Architectural designs and their approval, and BOQs will also be initiated at this stage. Table 17 shows an itemized list of these activities and costs.

Table 17 **Pre-operation costs**

S/N	*Particulars/activity*	*Quantity*	*Rate (UGX)*	*Amount (UGX)*	*Justification*
1	Project coordinator	12 months	2,500,000	30,000,000	Monthly remuneration for project coordinator
2	Office expenses (printing services and stationery)	12 months	400,000	4,800,000	Toner, printing paper, notebooks, pens, box files and others
3	Accounting, auditing and NEG activities	1	4,000,000	4,000,000	Facilitation for supervision
4	Community mobilization	5	1,000,000	5,000,000	Stakeholder meetings, preparation of reports, travel
5	Resource mobilization	1	5,000,000	5,000,000	Stakeholder meetings, preparation of proposals, travel
6	Monitoring and evaluation	1	3,000,000	3,000,000	Transport, records, reports for regular check-ups
7	Commissioning	1	10,000,000	10,000,000	Launching and promoting technology (drinks, food, public communication systems, brochures, invitation cards, tent hire, chairs)
	Total			**61,800,000**	

Source: Author

9.3 Operations

Operation costs are incurred in implementing and maintaining the project. Such costs relate to making the improved bricks and installing the eco-san toilet at Nakawa Vocational Training Institute, as well as supervision, maintenance, and monitoring and evaluation activities. Table 18 shows a detailed list of requirements.

Table 18 **Operation costs for construction of the eco-san toilet**

No.	*Particulars/activity*	*Quantity*	*Unit cost (UGX)*	*Total cost (UGX)*	*Justification*
1	Engineering designs for RWH system(s) and BOQs	1	3,000,000	3,000,000	Data collection, designs for installations, preparation of BOQs, engineering drawings
2	Installation of pilot eco-san toilet at Nakawa Vocational Training Institute	1	6,000,000	6,000,000	Expenditure for an eco-san toilet (bricks, roofing, doors and windows, cement, sand and gravels)
3	Supervision	1	3,000,000	3,000,000	Facilitation during installation of the systems (field) to the NEG and project coordinator
4	Operations and maintenance	1	2,000,000	2,000,000	Extra materials to repair system, transport
	Total			**15,000,000**	

Source: Author

Notes: The eco-san toilet is 1.5 m x 2 m and 3 m high, the building housing it is estimated to take six iron sheets, 4,000 bricks, two windows, two doors and a cemented floor, with no wall finishing. Cost includes construction costs. Cost of the building is estimated at 6,000,000 Ugandan shillings.

9.4 Project comparative analysis

An eco-san toilet block built from alternative technology fired bricks is compared with a similar eco-san toilet. The comparison is based on an eco-san toilet comprising two rooms separated by a wall, with dimensions of 1.5 m x 2 m per room. A detailed list of materials required to construct this kind of eco-san toilet is provided in table 19. Table 20 shows the requirements for the alternative technology fired bricks. The proposed eco-san toilet building has bricks made on site using alternative technology.

Table 19 **Market value for an eco-san toilet**

S/N	*Item/description*	*Quantity*	*Unit*	*Rate (UGX)*	*Amount (UGX)*
1	Roofing	1	LS	800,000	800,000
2	Bricks	4,000	pcs	300	1,200,000
3	Gravel	1	trips	150,000	150,000
4	Cement	30	bags	35,000	1,050,000
5	Sand	4	trips	100,000	400,000
6	Doors	2	pcs	400,000	800,000
7	Windows	2	pcs	20,000	400,000
8	Labor	1	LS	2,000,000	2,000,000
	Total				**6,800,000**

Source: Author

Notes: pcs is piece/pieces; LS is lump sum; trips is tipper truck trips of materials requested.

Table 20 **Proposed material requirements for an alternative eco-san toilet**

S/N	*Item/description*	*Quantity*	*Unit*	*Rate (UGX)*	*Amount (UGX)*
1	Roofing	1	LS	800,000	800,000
2	Alternative bricks	4,000	pcs	100	400,000
3	Gravel	1	trips	150,000	150,000
4	Cement	30	bags	35,000	1,050,000
5	Sand	4	trips	100,000	400,000
6	Doors	2	pcs	400,000	800,000
7	Windows	2	pcs	20,000	400,000
8	Labor	1	LS	2,000,000	2,000,000
	Total				**6,000,000**

Source: Author

Notes: pcs is piece/pieces; LS is lump sum; trips is tipper truck trips of material requested.

9.5 Alternative Bricks Project financial projections

The projected cash flow for the 12 months is shown in Appendix 4.

The cash flow shows the recommended periods and amounts of inflows and outflows for good project implementation. The following assumptions are made:

1. Funds will be received when needed. If Government funds they will be received on a quarterly basis.
2. The systems will be staggered according to the funding.
3. All other funds are given on a monthly basis where possible.

9.6 Proposed financing structure

Table 21 shows a fundraising structure for implementation of the project. The community is expected to contribute some resources and the project coordinator will also raise funds.

Table 21 **Proposed fundraising structure**

No	*Source*	*Amount*	*Percentage*
1	Grant	65,660,000	70
2	Microfinance	14,070,000	15
3	Contribution community	14,070,000	15
	Total	**93,800,000**	**100**

Source: Author

Note: Grants will come from Government of Uganda and other development partners; housing finance loans from banks and microfinance institutions; beneficiaries of the project will make contributions in kind and cash.

10. Expected impacts and outcomes

The implementation of appropriate technology for brickmaking has many significant impacts and outcomes to the Nakawa Vocational Training Institute. The project will benefit more than 200 students and their lecturers. Construction of an eco-san toilet will come with many advantages to the institute. The following sections elaborate these impacts and outcomes.

10.1 Expected project outcomes

The immediate outcomes from this project will be improved sanitation, preserved trees and a reduction in transported building materials.

(a) Improved sanitation
The eco-san toilet will contribute tremendously to the sanitation of the institute, helping to control the spread of diseases and odors.

(b) Preserved trees
Trees that would otherwise have been used in burning bricks for the construction of an eco-san toilet will be preserved for something else – furniture, for example – and contribute to preserving the community environment.

(c) Reduction in transported building materials
Bricks are among the highest percentage of materials used when building a house, especially in Africa. Making bricks on site will help to reduce the amount of materials being transported, and hence lower costs and improve incomes.

10.2 Expected impacts

Construction of an eco-san toilet will generate significant benefits to the institute, including a conserved environment and improved student health.

(a) Conserved environment
It is traditional in Uganda to make burned bricks using tree pieces. It is also acknowledged that making bricks this way contributes significantly to deforestation. The alternative technology for making bricks without fire will, therefore, bring great benefits to the local community. These include more sustainable farming and climate change adaptation, which will contribute to green cover and mitigate the levels of carbon dioxide (greenhouse gas) in the atmosphere. Trees produce consistent rainfalls, and indirectly bring improved food productivity due to well-maintained soil fertility.

(b) Improved student health

There is no doubt that student health is connected to the nature of the environment they live in. Educational development occurs in physical, social, cultural and psychological environments, which implies that a healthy environment is vital for fruitful learning. Constructing an eco-san toilet will help to create an environment that will foster better performance by students.

11. Risks and measures to address

The alternative technology for the brickmaking project, like all projects, may experience risks that could threaten its success. Therefore, it is essential to address these risks and take appropriate measures. Risk and mitigation planning is the process to identify and assess specific risks and develop actions to support opportunities and reduce threats to the project mission. Some risks will have already been identified at the proposal stage, others will emerge in subsequent phases. This document is delivered in the context of the bricks project but is also envisioned as a dynamic, changing document, intended to support management decision-making. A risk is a potential event or condition that could have a negative effect on a project's objectives. Risk management is the process of identifying, assessing, responding to, monitoring and reporting risks. This risk management plan defines how risks associated with the bricks project will be identified, analyzed and managed. It outlines how risk management activities will be performed, recorded and monitored throughout the project. In the bricks project, risk management and its associated mitigation efforts is differentiated in two areas:

1. **Internal risks**: include technical risks and directly relate to project progress; for example, service delivery and changes to the team and staff, the schedule and output.
2. **External risks**: risks that cannot be directly influenced by the bricks project team and can also hinder progress. They include inflation, causing cost and revenue changes, and changes to funders and sponsors, and laws and regulations.

Risk management includes up-front planning on how risks will be mitigated and managed once identified. Risk mitigation strategies and specific action plans are, therefore, included in the bricks project.

11.1 Measures to address risks (tools and practices)

Generally, risk mitigation plans should include the following:

- outline the root causes of risks that have been identified and quantified in earlier phases of the risk management process;
- evaluate risk interactions and common causes;
- identify alternative mitigation strategies, methods and tools for each major risk;
- assess and prioritize mitigation options;
- select and commit the resources required for specific risk mitigation options; and
- communicate planning results to all project participants for implementation.

How can these common project risks be tackled for optimal success? When employed together, the following tactics will help protect an organization and significantly reduce the prospects of falling victim to common project risks.

(a) Employ a risk register

Identifying risks prior to the start of your project is a great way to avoid common pitfalls. One way to do this is with a risk register (table 22 provides the bricks project risk register). It is created at the start of the project and acts as a tool to help project managers track issues and deal with them as they arise.

A risk register in project management and risk management is used to record details of all identified risks, along with their analysis and plans for how such risks will be handled. In short, a risk register or log identifies different risks and their severity, then provides actions and steps to mitigate them.

(b) Employ project management software

Project management software, such as Microsoft Project, allows users to streamline project tasks and activities, as well as plan work to the last detail. Software is one of the best options to avoid risks because it enables project managers to see problems in advance and plan accordingly. And when used with a risk register, all bases are effectively covered.

(c) Employ occasional project stakeholder meetings

Meetings can help to identify risks and also to change the course of the project accordingly. Occasional project meetings at different stages can be helpful.

Table 22 **Risk register for Alternative Bricks Project**

S/N	*Risk category*	*Risks*	*Measures to address*	*Effect of risk if unmitigated*
1	Project schedule	Delayed schedule leads to higher costs	To strictly keep to project schedules	Medium
2	Budget (cost and revenue variances)	Inflation which leads to increased project cost Revenue variance as a result of funders withdrawing	Allow for inflation in the budget Look for microfinancing and beneficiary contribution to make up the gap Maintain agreed terms with funders	High
3	Output performance changes	Worker strikes can cause lost production	Pay attractive compensation to increase staff motivation and retention.	High

4	Team and staff changes	Staff leaving for better pay and conditions	Make the package more competitive	High
5	Law and regulation changes	Regulation requirements by the district	Build quality control into the project Carry out regular testing and quality control to meet the standards	Medium
6	Funding and sponsor changes	Lack of sufficient funds for the project	Diversify funding sources	High
7	Scope	Possibility of scope creep	Maintain project scope	High
8	Technical	Software issues	Procure reputable software	Medium
9	Quality	Poor quality of the product	Apply standards and use qualified labor	High

Source: Author

12. Conclusions and recommendation

12.1 Conclusions

The alternative brick technology is appropriate and affordable for low-cost housing and other structures in Uganda. Based on research and development performance, the proposed technology can replace burned bricks, and thereby contribute to environmental protection. The proposed technology is appropriate for rural areas where it has the potential to create jobs for contractors and youths.

12.2 Recommendation

It is recommended that the alternative brick technology be implemented initially among the target group. If successful, it can be spread to other districts.

13. REFERENCES

Appendix 1: Checklist for building plan submission

Appendix 1 provides a checklist for building plan submission to Kampala Capital City Authority (KCCA), municipalities and town councils in Uganda

Physical planning and surveying documents	
1	KCCA application form filled in by client, client contact (phone number)
2	Copy of land title(s)
3	Search statement within a period of three months from date of issuance
4	Payment receipt(s)
5	Old approval plans for extensions and alterations, or submission of as-built drawings
6	From KCCA Drawing Office: 1) Recent cadastral print; 2) Topographical map
7	Survey report from registered surveyor (open boundaries, verify location and access, check encroachment, show road reserve)
Architectural documents	
8	Two copies of architectural drawings stamped and signed by a registered and practicing architect, architect's contact number, and application forms
9	Architects Registration Board (ARB) return form
10	Project brief by project architect
Engineering documents	
11	Structural application certification form
12	Two copies of structural drawings, stamped and signed by registered structural engineer for a storeyed building or structures such as swimming pools and retaining walls, engineer's contact number
13	Signed structural calculations (additionally for high-rise structures, such as those of 6+ storeys, include lateral loading design to take account of potential earthquakes and wind, etc.)
14	Geotechnical report for 1) Low-rise structures of 1–3 storeys in low-lying areas; 2) Low-rise large developments; 3) Medium- and high-rise developments
15	Excavation plan where required

16	Traffic Impact mitigation plan
17	Structural integrity report for extensions and alterations, or submission of as-built drawings
Environmental documents	
18	Environmental Impact Assessment report, neighborhood consent
19	Storm water management plan
Public health documents	
20	Mechanical drawings
21	Electrical drawings

Appendix 2: Stakeholder analysis for alternative brick technology

S/N	*Name of stakeholder*	*Role of stakeholder*	*Level of stakeholder influence on the appropriate technology project (high, medium, low)*	*Interest in the appropriate technology project*
1	Ministry of Lands, Housing and Urban Development	Responsible for formulating policy on land use and housing development	High	High
2	Ministry of Local Government	Responsible for decentralized local governments including, districts, subcounties and parishes	Medium	Medium
3	Ministry of Finance Planning and Economic Development	Government coordinating agency for donor funding	High	High
4	UN Habitat	Promotes transformative change in cities and human settlements through knowledge, policy advice, technical assistance and collaborative action to leave no one and no place behind	High	High
5	Makerere University, School of Engineering	R&D and innovations in building materials and sustainable construction technologies	High	High
6	Habitat for Humanity Uganda	Builds affordable housing in Uganda and operates a housing microfinance program	High	High
7	Housing Finance Bank	Leading lender of housing finance	High	High

8	Uganda Cooperative Alliance	Implementing the housing cooperative development	High	High
9	DFCU Bank	One of the leading lenders for housing	High	Medium
10	National Social Security Fund (NSSF)	Provides wholesale finance to banks for on-lending	High	Medium
11	Centre for Affordable Housing Financing Africa	Independent think tank working to support and grow housing markets in Africa for increased affordability	Medium	Medium
12	Shelter Afrique	Pan-African finance institution that exclusively supports the project and which seeks to mobilize low-income communities into housing cooperatives.	High	High
13	Microfinance Support Centre	Government of Uganda agency that provides microfinance to other microfinance institutions and SACCOs for on-lending	High	Medium
14	National Housing and Construction Company	Real estate developer	Medium	Medium
15	Uganda National Association of Building and Civil Engineering Contractors (UNABCEC)	Advocacy body for the construction industry	Medium	Medium
16	Engineers Registration Board (ERB)	Legal body for regulating the engineering profession	Medium	Medium
17	Uganda Institution of Professional Engineers	Professional body for engineers	High	High

18	Architects Registration Board (ARB), Uganda	Legal board for regulating the architecture profession	Medium	Medium
19	Institution of Surveyors of Uganda	Professional board for surveyors	Medium	Medium
20	NBS Housing Baraza	Annual media event on housing	Medium	Medium
21	Uganda National Bureau of Standards (UNBS)	Board responsible for drafting and enforcing standards in Uganda	High	High
22	Material Testing and Research laboratory, Ministry of Works and Transport	R&D in building materials	High	High

Appendix 3: Job description for project coordinator

In order to be able to successfully accomplish the above tasks, the project coordinator for the bricks technology project should have:

- Bachelor's degree in Business Administration/Economics/Engineering/Social Science/Natural Resources, preferably with a focus on water systems from a recognized/reputed university.
- At least five years of relevant working experience on projects, preferably in Uganda, with either a multi- or bilateral donor organization, or construction firm, or other private sector players, with responsibility for infrastructure projects, preferably in the building sector.
- Strong problem-solving and analytical capacity, and ability to prioritize activities, identify relevant issues and trade offs, and provide appropriate recommendations.
- Excellent oral and written communication skills in English, as well as strong presentation and communication skills to a wide range of audiences.
- Demonstrated ability to interface effectively and collaborate and communicate with different clients and partners, from the public and the private sector, as well as demonstrate intercultural competence.
- Demonstrated ability to work flexibly on a range of assignments, adjust to changes in schedule and priorities, and juggle concurrent tasks effectively and efficiently.

Appendix 4: Financial projections

The Cash Flow Statement follows.

Cash flow statement

Fiscal year begins:	(Pre) Startup	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1/2/2023	EST	02	02	02	02	02	02	02	02	02	02	02	02	Item EST
Cash on hand (beginning of month)	-		5,600,000	11,200,000	12,940,000	72,200,000	66,800,000	56,400,000	49,000,000	44,600,000	29,700,000	25,300,000	20,900,000	20,900,000
Cash receipts														
Balance brought forward	-													-
Grant					65,660,000									65,660,000
Community contribution		10,000,000	10,000,000	8,140,000										28,140,000
Total	-	10,000,000	10,000,000	8,140,000	65,660,000	-	-	-	-	-	-	-	-	93,800,000
Total cash available (before cash out)	-	10,000,000	15,600,000	19,340,000	78,600,000	72,200,000	66,800,000	56,400,000	49,000,000	44,600,000	29,700,000	25,300,000	20,900,000	114,700,000
Cash paid out														
Technology development														
Consultancy fee		2,000,000	2,000,000	1,000,000										5,000,000
Material costs		2,500,000	2,500,000											5,000,000
Lab expenses			7,000,000											7,000,000
Project management costs														-
Project coordinator		2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	30,000,000
Office expenses (printing & stationery)		400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	4,800,000
Accounting, auditing & NEG activities		500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000					4,000,000
Community mobilization		1,000,000	1,000,000	1,000,000	1,000,000	1,000,000								5,000,000
Resource mobilization				2,000,000	2000000	1000000								5,000,000
Monitoring & evaluation										1,000,000	1,000,000	1,000,000		3,000,000
Commissioning										10,000,000				10,000,000
Project piloting														-
Engineering designs & BOQs							3,000,000							3,000,000
Installation of pilot systems							3,000,000	3,000,000						6,000,000
Supervision of installation							1,000,000	1,000,000	1,000,000					3,000,000
Operations & maintenance										1,000,000	500,000	500,000		2,000,000
														-
Other (specify)														-
Other (specify)														-
Miscellaneous														-
Total	-	4,400,000	4,400,000	6,400,000	6,400,000	5,400,000	10,400,000	7,400,000	4,400,000	14,900,000	4,400,000	4,400,000	2,900,000	75,800,000
Cash paid out (non P&L)														
Loan principal payment														-
Capital purchase (specify)														-
Other startup costs														-
Reserve and/or escrow														-
Owners' withdrawal														-
Total	-	0	0	0	0	0	0	0	0	0	0	0	0	-
Total cash paid out	-	4,400,000	4,400,000	6,400,000	6,400,000	5,400,000	10,400,000	7,400,000	4,400,000	14,900,000	4,400,000	4,400,000	2,900,000	75,800,000
Cash position (end of month)	-	5,600,000	11,200,000	12,940,000	72,200,000	66,800,000	56,400,000	49,000,000	44,600,000	29,700,000	25,300,000	20,900,000	18,000,000	38,900,000

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