

Design and Construction of Smart Toilet using Bamboo Architecture in Bauchi

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Abstract

The design and construction of smart toilets using bamboo architecture present an innovative solution to address the sanitation challenges in Bauchi, Nigeria. This research explores the potential of combining sustainable bamboo materials with modern smart technologies to create eco-friendly and efficient sanitation facilities. Bamboo, being an abundant and renewable resource, offers a low-cost, durable, and environmentally friendly alternative for construction. The research aims to integrate smart technologies such as automated flushing systems and water-saving mechanisms to enhance the usability and sustainability of these toilets. The focus is on creating toilets that are not only functional but also in harmony with the local climate, culture, and environment, leveraging the natural cooling properties of bamboo and its adaptability to various designs. Furthermore, the project emphasizes the need for community involvement in the design phase, ensuring that the end product meets the specific needs and preferences of the users. It is recommended that achieving sustainable architecture and sanitation in Nigeria highlights the role of local materials such as bamboo with other smart technologies to improve health and well-being in the built environment.

Keywords: Smart Toilets, Bamboo Architecture, Built Environment, Sustainable Construction, Specific Needs.

Introduction

Access to proper sanitation facilities remains a significant challenge in many parts of Nigeria, particularly in Bauchi State. The lack of adequate toilet facilities contributes to health issues such as waterborne diseases and environmental degradation. Traditional toilet designs often fail to meet the needs of local populations while also being unsustainable (World Health Organization, 2020). This research proposes a solution through the design and construction of smart toilets utilizing bamboo architecture.

Public health implications and the consequences of inadequate sanitation are dire. Poor sanitation facilities are directly linked to the spread of diseases such as cholera, typhoid fever, and dysentery (World Health Organization, 2020).

Waste management challenges is a significant aspect of sanitation that remains a challenge in Nigeria. The inefficient collection of waste, insufficient disposal facilities, and a lack of public awareness contribute to the crisis (Igbinomwanhia et al., 2009). In many urban areas,

waste is often dumped indiscriminately in open spaces or water bodies due to inadequate collection services (Audu & Osunkunle, 2014). The accumulation of waste not only poses health risks but also leads to environmental pollution and degradation.

The significance of bamboo as an underutilized resource in many regions despite its numerous advantages. It is fast-growing, renewable, and has excellent structural properties (Liu et al., 2019). Incorporating bamboo into toilet design not only provides a sustainable building material but also enhances aesthetic appeal and environmental compatibility. Sanitation challenges in Nigeria are exacerbated issues by rapid urbanization and inadequate infrastructure (Ogunbode et al., 2018). The World Bank (2019) reports that millions lack access to basic sanitation facilities, leading to significant public health concerns.

Statement of the Problem

The design and construction of smart toilets using bamboo architecture in Bauchi face significant challenges, including inadequate sanitation infrastructure and limited public awareness of sustainable practices. The reliance on conventional materials hinders innovation, while bamboo's potential for eco-friendly solutions remains underutilized, impacting both health outcomes and environmental sustainability.

Literature Review

Sanitation challenges in Nigeria are a critical public health issue, where inadequate access to sanitation facilities has led to significant health challenges. Rapid urbanization, population growth, and insufficient infrastructure exacerbate these sanitation challenges, particularly in urban areas like Bauchi. According to the World Bank (2019), millions of Nigerians lack access to basic sanitation services, resulting in severe public health implications, including the spread of waterborne diseases. This literature review examines the factors contributing to sanitation challenges in Nigeria and explores potential solutions. Urbanization and its impact on sanitation in Nigeria has experienced rapid urbanization over the past few decades, with urban populations increasing significantly. Ogunbode et al. (2018) highlight that this urban migration has outpaced the development of necessary infrastructure, including sanitation facilities. As cities expand, informal settlements often emerge without proper planning or sanitation services, leading to increased waste generation and inadequate waste management systems (Ogunbode et al., 2018). The lack of infrastructure not only hampers access to sanitation but also contributes to environmental degradation as waste accumulates in public spaces.

Economic constraints and c factors play a crucial role in the sanitation crisis. Developing countries like Nigeria often struggle with limited financial resources allocated for sanitation projects (United Nations, 1997). Many households cannot afford proper waste disposal services, leading them to resort to open dumping or burning waste without considering

environmental consequences (Igbinomwanhia et al., 2009). A shortage of trained personnel hampers effective planning and implementation of waste management strategies. Many local government officials lack the necessary technical knowledge to manage solid waste effectively and sustainably (United Nations, 1997). This gap in expertise leads to inefficient systems that fail to address the growing waste problem.

Institutional constraints of numerous agencies exist at various levels of government tasked with managing solid waste; however, their roles are often unclear or overlapping (Ogawa, 1996). This lack of coordination results in ineffective management strategies and poor service delivery. The absence of a central authority responsible for overseeing solid waste management exacerbates the challenges faced by local communities.

Community engagement and awareness involvement is essential for addressing sanitation challenges effectively. Engaging residents in discussions about their needs and preferences can lead to more appropriate solutions tailored to local contexts (Audu & Osunkunle, 2014). Public awareness campaigns can also educate communities about proper waste disposal methods and the importance of maintaining clean environments. This engagement fosters a sense of ownership among community members regarding their sanitation facilities in line with sustainable development goal 6 of Water Sanitation and Hygiene (WASH).

Sustainable solutions are geared to tackle the sanitation crisis in Nigeria effectively, sustainable solutions must be prioritized. These include:

- i. Investment in Infrastructure: Enhancing existing infrastructure and developing new facilities tailored to urban growth can improve access to sanitation.
- ii. Policy Reforms: Government policies should prioritize sustainable practices by allocating adequate funds for sanitation projects and promoting community engagement initiatives.
- iii. Adoption of Smart Technologies: Integrating smart technologies into waste management systems can optimize collection processes and reduce costs (Mizutani et al., 2020).

Methodology

The design process involves collaboration with local communities to ensure that the toilets meet their specific needs while utilizing bamboo as the primary material and construction methods. The construction technique will employ traditional joinery methods combined with modern techniques to enhance durability while maintaining aesthetic value as shown below:

Materials for the sub-structure are as follows:

1. After obtaining all the materials for the substructure, the site for the toilet construction will be determined for clearing and setting-out which will be followed by the digging of the toilet trench. The septic tank must be installed next to the toilet to avoid bends in pipes, and at a lower level of terrain, away from water wells.

The minimum distance from a source of water is 50 metres, so that there will not be any contamination of the water in the event of a leak.

2. Put the bamboo materials together following a step-by-step approach.
3. The next step is to finalize the trench that will receive the materials. The trench should measure approximately 1.4m depth, 1.5m width and 3m length.
4. Make provision for septic tank or direct pit.
5. Place the substructure, Midstructure and superstructure appropriately.
6. Install the access for the PVC pipe and 90° quarter bend with 90cm of depth. Install the exit pipe at the height of the first module and insert a 90° elbow on its end.
7. Prepare a trench to bury the drain. The depth should be compatible with the slope of the terrain.

Results and Findings

This work indicated that Bamboo as a sustainable material can significantly reduce the carbon footprint associated with construction (Zhang et al., 2021). Its rapid growth cycle allows for sustainable harvesting without long-term ecological damage. The proposed smart toilet design incorporates features such as:

- i. Automated flushing systems.
- ii. Water-saving mechanisms.
- iii. Natural ventilation facilitated by bamboo's properties.
- iv. Initial feedback from community members indicates strong support for the use of bamboo toilet due to its availability and cultural significance as shown in Figure 1.



Fig. 1: Typical Bamboo Toilet

Source: [African Climate Reporters](#) (May 27, 2021).

Conclusion

The design and construction of smart toilets using bamboo architecture represent a forward-thinking approach to addressing sanitation challenges in Bauchi State. By leveraging local resources and integrating modern technology, this project aims to create sustainable solutions that improve health outcomes and enhance community well-being. Sanitation challenges in Nigeria are multifaceted and require comprehensive strategies that address economic, technical, institutional, and social constraints. By investing in infrastructure, promoting community engagement, and adopting innovative technologies, Nigeria can improve its sanitation landscape significantly. Addressing these challenges is crucial not only for public health but also for achieving broader developmental goals.

Recommendations

- i. Policymakers should support initiatives promoting bamboo construction.
- ii. Community training programs should be established to raise awareness about sustainable practices.
- iii. The integration of bamboo architecture with smart technologies presents a viable pathway toward sustainable sanitation solutions in Bauchi
- iv. This approach not only addresses immediate sanitation needs but also promotes environmental stewardship.

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