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Barrier to the use of Sandbag Material Technologies as a Sustainable Affordable Housing Solution: Perspectives from South Africa

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Abstracts: over 12.5 million families in South Africa live in slums without access to adequate housing. Previous studies projected that meeting housing demand in South Africa will take hundreds of years with the available resources and technologies. Therefore, achieving sustainable and affordable housing solutions remain a pressing goal. This study assessed the perception of experts and end-users on the barriers to the use of sandbag material technology as a Sustainable Affordable Housing Solution in South Africa. The study draws on focus group discussions held with 12 leading experts on alternative technologies and local South African end-users to obtain data to address the research objective. It emerged that lack of social acceptance, lack of support from the government, limited Professional Expertise, and Access to finance are barriers to the use of sandbag material technology in South Africa. The study concludes with some recommendations and adds significantly to the limited knowledge on alternative building material technologies such as Sandbag technology.

Key Words: Affordability, Alternative Building Technologies (ABTs), Building Materials, Housing, Sandbags, Sustainability

Introduction

Housing is a fundamental need of humans. Housing provides essential security, safety, and shelter needs. However, approximately 1.6 billion people – more than 20% of the world's population lack adequate housing, and an estimated 100 million people are homeless (Adabre et al., 2020). About 12.5 million families don't have access to adequate housing (Grady et al., 2019). This suggests that the existing construction methods and materials are incapable of solving the problems of inadequate housing and a need for alternative building materials. Sandbags (typically known as earthbags or soil bags) are polypropylene bags or polymer materials filled with granular materials. The sandbag has been proposed as an affordable, sustainable, recyclable, and alternative building material capable of providing access to housing (Cataldo-Born et al., 2016).

Despite the advantages of Sandbag Building Technology (SBT) and its potential to bridge the housing deficit in South Africa, its adoption in housing construction is low. Botes (2013) and Salzer et al. (2016) found that conventional brick, concrete, and steel houses are most preferred and considered modern by an average person. South Africans perceived that houses constructed with sandbags were only meant for the poor. They expressed their preference to live in a house built with conventional materials; brick, concrete blocks, and mortar (Grady et al., 2019). This is evident as the preponderance of the South African built fabric comprises traditional material, including bricks, concrete blocks, and mortar (Dlamini 2020). Therefore, to enhance the comprehensive implementation of sandbag technologies in housing delivery in South Africa, it is crucial to determine the local experts' and end-users' perceptions of the barriers to the use of sandbag technologies as a sustainable and affordable housing solution in South Africa.

In the light of the above background, this study evaluates the level of use and perception of the local experts and end-users on the barriers to the use of Alternative Building Technology (ABT) such as sandbag building technologies as a sustainable and affordable housing solution in South Africa.

The Concept of Sustainable Affordable Housing (SAH) and Use of Sandbag Material Technology

According to Pullen et al. (2010) a sustainable, affordable housing concept (SAH) is "housing that meets the needs and demands of the present generation without compromising the ability of future generations to meet their housing needs and demand." Sustainable Affordable Housing (SAH) provides an economic benefit, improved occupant health, comfort, energy, and water efficiency while also reducing cost (Golubchikov and Badyina, 2012). Sustainable Affordable Housing (SAH) provides an 80% reduction in energy (Adabre et al., 2020). Affordable housing is when a household spends less than 30% of its income on housing (Friedman and Rosen, 2018). A house is sustainable when it is of good quality, in a good location for a lower-middle-income household, and the cost is reasonable to allow a household to meet other basic living costs on a sustainable basis (National Summit on Housing Affordable, 2006).

Sandbag building technology (SBT) provides economic and environmental advantages to affordable houses in many developed and developing countries. It is an earthen architecture that uses locally available soil placed in woven bags filled and stacked to form a building (Rincon, 2019). Castaldo-Born et al. (2016) found that houses constructed with SBT consume less energy during construction and operations. It also regulates the internal temperature of the building by absorbing excess heat during the day and releasing it at night, thereby providing a relaxed internal environment in hot and warm weather (Rincón et al., 2019; Shaker et al., 2017). More so, economically, SBT is relatively cheaper than conventional technologies. The approximate cost per square meter of a sandbag house in India and South Africa is 7.55 and 242 US dollars, respectively (Ecobuilder, 2019). Despite the benefit of SBTs, their adoption is low in South Africa.

Even though researchers and manufacturers view that adopting SBTs is crucial to solving the housing deficit in South Africa by delivering sustainable and affordable housing. Little or no recent research has been done on evaluating the barriers to adopting SBTs as alternative methods of construction in South Africa.

Research Methods

This research adopted a qualitative research approach that employed focus group interviews as the primary method of data collection for this study. The qualitative descriptive study was guided by Cresswell and Clark's explanation of qualitative descriptive studies (Cresswell and Clark, 2004). Consistent with qualitative descriptive research, this research wasn't carried out based on any prior theoretical or philosophical orientation. It follows an inductive content analysis approach, where codes were directly derived from text data. Hence, the research employed a purposive sampling technique to gain in-depth information of both the experts' and end-users' perceptions of the barriers to adopting sandbag technologies in South Africa. Focus group participants for the present study comprised of SBT experts and end-users in South Africa. Table 1 shows the demographic profile of the focus group participants and their expertise.

Data Collection

Cape Town was selected as the appropriate location for the focus groups discussion. A range of experts across the South African construction industry was present physically, while others joined online. Two focus group discussions with 6 participants each were held in Cape Town, thus within the acceptable range of 6 to 15 as Morgan (1997) advised. Previous research demands at least two focus group sessions for research methods relying on focus groups data (Guest et al., 2017). The two focus group sessions addressed two general questions which sought the perspectives and opinions of the experts and end-users regarding the objectives of the present study. The general question is; what are the barriers to adopting ABTs such as sandbag materials in South Africa?

The primary aim of the focus group discussion is to generate data from the discussion of the participants, not to impose consensus, and the two sessions were managed to achieve this aim. The discussion was recorded with a video camera, and it lasted for 2 hours. Also, some of the participants made formal presentations to clarify their arguments and point. The video recording and other output generated during the focus group discussion were transcribed.

ID	Involvement in sandbag technologies	Experience with SBTs (Years)
C1	An SBT expert and the CEO of a sandbag construction company	25
C2	United Nations researcher on infrastructural investment, green building and biomimicry	20
C3	A doctoral researcher on sustainable and affordable housing in South Africa.	15
C4	A quality assessor inspector at the Centre for Research in housing innovation	25
C5	A researcher on alternative construction	8
C6	An occupant of an SBT house in South Africa	3
D1	A leading researcher on Alternative Building Technologies	25
D2	A leading researcher on Alternative Building Technologies	30
D3	A researcher on sustainable and affordable housing in South Africa.	5

D4	An SBT expert and the CEO of a sandbag manufacturing company	25
D5	An Associate Professor and an expert researcher on sustainable construction	13
D6	An occupant of an SBT house in South Africa	3

Table 1: Profile of the focus group member

Data Analysis

The audio-recorded data were transcribed verbatim and analyzed using NVivo 11 software packages. Open coding was conducted, which entails a line-by-line or verbatim examination of data where qualitative data were selected into the unit of meaning. Furthermore, the various codes emanated from the selected data were used to mark the critical point, and these were grouped into various concepts. Then, this concept was further divided into codes and subcodes. The number of references to each code was used as a basis for accessing the relative importance of each code. According to Chileshe et al. (2016), in analyzing qualitative data in construction research, several references to codes are treated to indicate their weight and relative importance. Bazeley (2007), notes that "people repeat ideas that are of significance for them."

Code (references)	Subcodes
1. Social acceptance (17)	<ul style="list-style-type: none"> • Poor-quality house. • Burnt down houses • Poverty
2. Government support (11)	<ul style="list-style-type: none"> • Building codes and regulation • Scarcity of sand in South Africa
3. Professional expertise (9)	<ul style="list-style-type: none"> • Ego • Limited life span
4. Preference for brick(7)	<ul style="list-style-type: none"> • Lack of knowledge • Awareness
5. Access to finance (4)	

Table 2: NVivo thematic classification

Validity and Reliability

The study follows the recommendation of Rosenthal (2016) that direct quotations of the respondent should be presented to demonstrate the reliability and validity of the data. Hence, the themes were accompanied by direct quotations of responses attributed to the participants in the focus group discussion. More so, it is subjected to an NVivo word frequency analysis to check for word consistency, as shown in Figure 1.

The experts interviewed noted that the people burned down most alternative building technology houses built in the informal settlement because the community does not accept and approve it. *"People have burnt down houses that were built for them in Frieda. We built 600 houses in Frieda, they were built with polystyrene, and when the contractors started, they were burnt down. When the community doesn't accept and approve a house made of sandbag" - (Participant C2).*

More so, experts noted that the community threaten their lives. The project team was stoned and forced to leave the townships due to people's lack of acceptance and approval of this technology. *"What would it entail because we have tried building the houses in Townships like Khayelitsha, and we were stoned and told to get out. If I had stayed there for five more minutes, I probably would have been killed" (Participant D4).* This finding is consistent with extant studies that have linked the low adoption of earth technology to end-users lack of social acceptance (Kulshreshtha et al., 2019; Lyamuya et al., 2013).

Social acceptability emerged as an essential factor that needs to be addressed in adopting SBT in affordable housing in South Africa; when people do not accept a concept, implementing it may be difficult. According to research by Wustenhagen et al. (2007), for a technology to be widely adopted, it has to be accepted by the end-users, professionals, investors, and the Government.

Preferences for Conventional Material

It emerged from the expert discussion that preference for conventional materials among community members plays a massive role in the non-acceptance of ABTs (seven references as shown in Figure 2). South Africans have a preference for houses built with brick and concrete. Most especially in the informal settlement of South Africa, they believe an alternative building technology house such as sandbag is meant only for the poor. *"One of the issues is South Africans have a natural likeness for houses constructed with bricks and concrete, and they believe an alternative building house will tag them as poor. And there is the issue of people often saying; we don't want to be seen as poor people" - (Participant D3)*

There was a consensus among the experts that most people believe houses constructed with alternative building technology are of poor quality and have limited life spans. The experts agree that if the community does not accept this technology, it may never be implemented. *"People believe that because a house is built of sand, it is of poor quality and has a limited life span. When the community does not accept a concept, it will never be implemented" (Participant C3).* This agrees with the study of Reddy and Mani (2007). They concluded that increased adoption of energy-intensive conventional construction led to a steep decline in the uptake of sandbag construction.

Government support

It emerged from the discussion of experts that there is no support from the Government in terms of established building regulation codes and policy on alternative building technologies such as sandbags in South Africa. *"However, as much as we've tried in South Africa, we've never been able to achieve this because the perception is not good, and I don't think there's a will from government to accept it" (Participant M9)* shown in Figure 2. Government support was seen as a significant barrier with 11 references, compared with professional expertise (9 references), preference for brick and block (7 references), and access to finance (4 references). Experts attributed this to the lack of adequate published research on the performance of alternative building technologies such as sandbags. *"Government can*

only have confidence when there are published results on the performance of sandbag housing" (Participant D1). This is consistent with Rincon et al.'s (2019) research, where he observed an absence of general recommendations by the government and building codes for sandbag technologies

Professional Expertise

Professional expertise was predominantly seen as a barrier with nine references, as illustrated in Figure 2. It emerged from the expert discussion that construction professionals' perception of sandbag technology plays a significant role in implementing SBTs in South Africa. Experts argue that construction professionals do not understand the sandbag construction process. Hence, a practical understanding of the specifications of sandbag construction limits the successful implementation of this method of construction. *Participant C5 notes that "construction professionals ought to understand the process of constructing using sandbags and what needs to be done to prevent issues like cracking and using multiple materials."* This is consistent with Grady et al.'s (2019) and Ugochukwu's (2015) research, where they observed that most professionals prefer to use conventional building materials and technologies than alternative building technologies because they are more familiar with the latter.

Access to finance

The respondents discussed finance access, the least rated barrier with four references illustrated in Figure 2. Based on the experts' argument, it emerged that banks refused to offer bonds/mortgages for sandbag houses. Without this type of investment, it is hard to own a sandbag house or get enough funding to build one. According to *Participant C1 "banks will not finance it, and this is probably the biggest problem"*. Leverage (2017) noted that many investors are unfamiliar with the technology and efficiency of ABTs. Therefore, accessing housing credit and insurance from financial institutions is almost impossible. (Zami and Lee, 2011). However, some experts argued that the financial institution's support depends on the Government's approval. *"Banks don't have a problem as long as the Government has approved the system; I don't think there will be any problem since the sandbag system has been there for some time" (Participant C5)*

This study has contributed to the limited body of knowledge of barriers hindering the use of SBTs in South Africa through a focus group discussion with experts and end-users in South Africa. It is expected that when the barriers are overcome, the stakeholders will be keen to adopt ABTs instead of conventional building materials in housing construction in South Africa.

Conclusion and Recommendations

Achieving sustainable and affordable housing solution remain a pressing goal. This study assessed the perception of experts and end-users on the barriers to the use of alternative building technologies (ABTs) such as sandbag material technology as a sustainable affordable housing solution in South Africa. This study found that the perceived barriers to the use of ABTs such as sandbag material technology comprise of social acceptance (17 references), lack of support from the Government (11 references), limited Professional Expertise (9 references), and Access to finance (4 references). The social acceptance of sandbag houses was perceived as the most significant barrier to the use of SBTs in South Africa. This study revealed that South Africans do not accept or approve the SBTs on housing projects. Due to end-users' lack of acceptance and approval of this technology project teams

implementing SBTs have been stoned and forced to leave project sites. This study established that South Africans view that houses built with alternative building technology are inferior and associate them with poverty and therefore prefer to stay in a brick and blockhouse.

Based on these findings, the study concludes that achieving a sustainable and affordable housing solution in South Africa through the use of alternative building technologies such as SBTs is hindered by the lack of social acceptance of the technologies by the end-users, professionals, and investors, lack of support from the Government, preferences for conventional building technologies, lack of professional expert knowledge and access to finance

The study recommends that workshops and seminars be held by the promoters of SBTs to create awareness of the benefits of sandbags by the stakeholders. Scholars view that multiple and continuous educative outreach efforts of the economic and environmental benefits could improve the perceptions of ABTs among citizens. The study also recommends that promoters should build SBT demonstration projects across all provinces in South Africa because People become more accepting of ABTs once they physically experience a house made from the technology. Also, community members should be trained and involved in the construction process.

This research extends the knowledge of SBTs beyond intelligent guesses and arguments to capture the view of the local expert and end-users on barriers to the use of ABTs such as Sandbag material technology as a sustainable, affordable housing solution in South Africa. Thus, this study adds significantly to the limited body of knowledge on alternative building technologies, focusing on SBT houses. Consequently, the findings provide policymakers with information on the barriers to the use of ABTs in housing construction. It also provides policymakers with strategies for overcoming the barriers identified. Further studies on the barriers to the use of alternative building technologies barriers in different locations are recommended.

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