

A Review of Barriers to the Adoption of Smart Building Concepts (SBCs) in Developing Countries



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Abstract The smart building concept is becoming more popular in construction in recent times. This is because the world is embracing digitization in response to the advent of new technologies. The call for high building performance and sustainable development has brought about the adoption of smart building concepts in the construction industry. The Smart Building Concept adoption has not been without hindrances occasioned by several constraints undermining the efforts that aid its adoption. This paper intends to review systematically extant literature on barriers undermining the adoption of SBCs, considering papers published in peer-reviewed journals and conferences. The study reviewed 30 relevant articles through topical analysis of the article then followed by abstract and the finding of the paper selected concerning barriers to the adoption of SBCs, and barrier frequency was employed to select the most reported ones. The study revealed the most reported barriers undermining the adoption of SBCs as the high cost of initial construction, vague objectives, lack of guidelines to manage SBC, lack of government incentive and policy, lack of knowledge on the smart building by contractors and professionals, and resistance to change from the use of traditional technologies among others. For SBCs to thrive in developing countries, there is a need to mitigate the identified barriers to their adoption.

Keywords Smart building concepts · Sustainable construction · Smart building barriers and Smart building technologies

1 Introduction

The smart building concept is gaining more attention as a means of sustainability in the building sector of the construction industry due to growing public concern about the environmental impact [1]. The smart building concept has gained popularity

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among construction professionals and academics who are working to preserve the environment and advance the construction industry's building sector [2]. Sustainable construction is an essential strategy to minimize a building's environmental impact, and it entails the integration of new methods based on inter-disciplinary knowledge. The smart building concept has been recognized by professionals, the government, and the global community as a blueprint for improving the sustainability of the building construction industry. The smart building concept is considered the practice of using smart technology in creating structure, energy reduction, improvement of occupant comfort, and satisfaction that are environmentally sustainable [3]. According to [4] smart building concept forms part of sustainability a key driver in the economic efficiency, ecology balance system in protecting and restoring as well as improving human life.

1.1 Smart Building Concept

A smart building is a building that provides dynamic real-time control in managing the internal and external activities of the building [5]. According to [6] a smart building has an integrated platform for monitoring energy use, intelligent facilities management, and the use of surveillance video for security systems. Smart buildings contain intelligence with building automation as an important aspect of their management [4].

Presently, the increasing number of smart devices, smart sensors, smart materials, and smart cities have been adopted and gradually been implemented in developing countries such as South Africa [7]. Research has indicated that there are difficulties in defining in clear terms the concept and target of smart buildings [8]. Notwithstanding, its concept could be established concerning the time, culture and needs within a particular country or continent. While some continents concentrate on the adoption of SBC for the improvement of environmental quality, some other countries concentrate on its economic benefits in achieving low-carbon economic goals [8]. In addition, some countries embrace the smart building concept due to the increased environmental performance, operation and safety as well as reliability of various technologies in automation, control and communication associated with its adoption. The benefit of sustainability over the years has brought about the promotion of the smart building concept adoption which has been of great importance to many countries. However, the smart building concept is not free from barriers hindering the adoption in the building sector of the construction industry. According to [9] the barriers must be first recognized and understood. However, few studies have been conducted on the barriers to the adoption of smart building concepts in developing countries [4]. In a similar study by [10], they called for the incorporation of intelligent buildings in the architectural curriculum in tertiary institutions in Nigeria. There is a gap in the literature in terms of smart building adoption barriers in developing countries [11, 12].

2 Literature Review

The smart building concept allows a transition from traditional construction methods to industrial production by increasing the use of standardised components and production offsite [13]. Adopting the smart building concept offers a significant sustainable benefit that is greater than that of conventional traditional building technique practice in developing countries such as Nigeria [10]. Ref. [14] revealed the smart building learns from the experience to make the most effective decisions in real-time to maximize comfort and productivity while using the least amount of energy possible. By implementing SBC many benefits such as improved technologies in communication within a building as well as increased technologies in automation and control can be achieved.

2.1 *Barriers to Smart Building Concept Adoption*

Despite the increased perception of SBC benefits, there are still barriers to their adoption [4]. The barriers to the smart building concept in the building construction industry have been investigated in the developed countries but not so much in developing countries. According to [15] lack of financial incentives and a regulatory environment favorable to adopting the smart building concept. Similarly, [16, 17] identified the following as barriers to smart building, the high initial cost of smart building construction compared to conventional building, lacks of financing schemes, lacks of government incentives, unavailability of smart building suppliers, lack of institutes for research development of smart building technologies, a high degree of distrust about Smart Building concept among professionals and client, resistance to change from the use of traditional technology, lack of interest from client and market demand [1]. Identified a higher cost of a smart building, lack of technical expertise/skill, interoperability, difficulty to change consumer behaviour as barriers to SBC adoption. Ref. [10] reported that low quality of maintenance culture, lack of awareness, insufficient power supply in the country are the major barrier to the adoption and implementation of smart buildings. In the same vein, [8] discovered a lack of guidelines and framework, lack of client involvement in the design process, high cost of smart building materials, and lack of smart building definition as a major barrier facing the Egyptian building construction industry. Ref. [9, 16, 18] identify lack of smart building promotion by the government, long payback period, lack of financing schemes, and risks and uncertainties involved in adopting new technologies. Ref. [4, 19] discovered that extension of project schedules, resistance to change from traditional practices, unavailable smart building material, and equipment, planning of different construction techniques, lack of government policy, level of risk the client is willing to take our part of the challenges in smart building technologies. In Indian, [20] discovered that lack of ability to meet electric power demand,

unavailability of solar radiation data, and lack of political commitment are the major barriers to smart building.

3 Research Methodology

The essential basis of progressing in the knowledge of a subject is a relevant review of literature on the subject [21]. This essentially eases theory development that is beneficial to industrial and academia at large. This study is based on the review of literature on barriers to Smart Building concept adoption. The review focused on the issues surrounding smart building adoption that have been published in academic publications and conference papers. A literature search was undertaken with the use of the Scopus search engine. This method has always been employed to find relevant papers for studies because of its recovering precision and accuracy in performance [4, 22]. The search keywords used are “smart building barriers”, “smart building concept”, and “smart building technologies”. A total of 150 Articles were found during the initial search that was conducted systematically [searched on April 2021]. However, not all of the publications found are related to the research of smart building adoption barriers. It was necessary to filter out unrelated papers because the goal of the study was to analyze literature studies on the barriers to smart building concept adoption in the construction industry’s building sector. Following the screening process, 30 articles were identified as being relevant for further investigation. To review the 30 relevant articles, the study used a systematic review technique through topical analysis of the article then followed by abstract and the finding of the paper selected to discover common barriers to SBC adoption. This study focuses on reviewing and making conclusions from relevant publications that were found, rather than a comprehensive evaluation of the entire population of literature on the subject (Fig. 1).

4 Discussion

About 60 barriers to smart building concepts were discovered after a systematic review of 30 articles. The identified barriers were crystallized into four major categories namely: economy-related barriers, government-policy-related barriers, technical related barriers, and Social- human-related barriers [1, 9]. many barriers to adoption of smart building concepts in developing countries as seen but the most commonly reported barriers are the high cost of initial construction from adopting smart building concepts, higher cost of smart building technologies, lack of government incentive and policy, and lack of knowledge on smart building technologies.

The categorized barriers are presented in Table 1

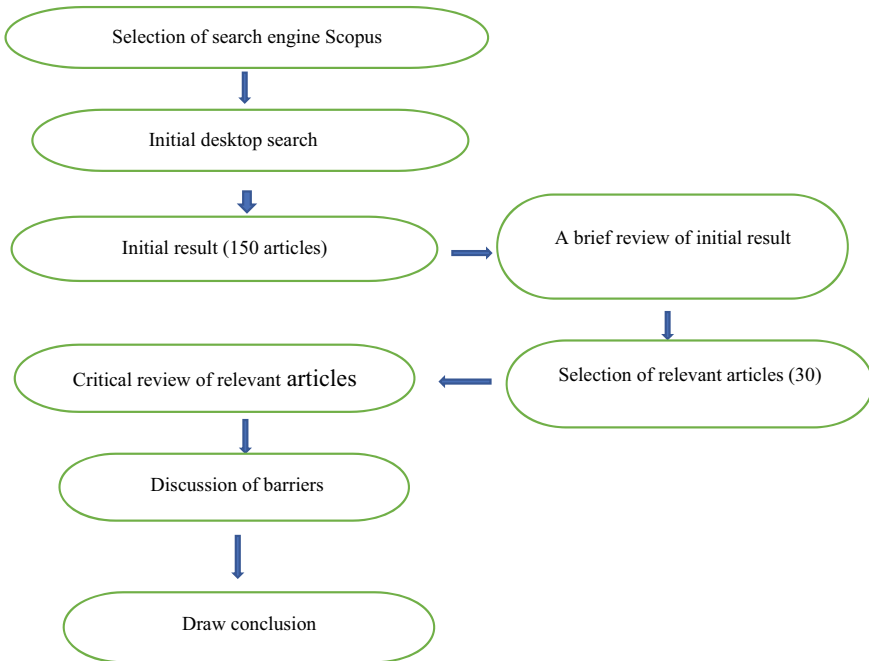


Fig. 1 Systematic research flow chat. *Source* Adapted source: Ghansah et al. [4]

5 Conclusion and Recommendation

This study was conducted as a systematic review of literature on the barriers to smart building concept adoption in developing countries, with the help of data-bases that were used to collect relevant academic journals and conference pa-pers. From the comprehensive literature review, many barriers are preventing the adoption of smart building concepts in developing countries as seen but the most commonly reported barriers are the high cost of initial construction from adopting smart building concepts, higher cost of smart building technologies, lack of government incentive and policy, and lack of knowledge on smart building technologies. To overcome these barriers, this study recommends that government should establish a common platform for collaboration of all stakeholders such as professionals in the construction industry by way of policymaking and provision of funds for research and development towards implementation of these smart technologies. This will go a long way for employment creation and better improve the economy of the countries. Also, government support may be a very good instrument in promoting smart building concepts. Government should consider, for example, waiver on tariff cost of importation of smart building materials, provision of the financial scheme to encourage the usage of the smart building. According to [4] government play a vital role in the promotion and adoption of smart building in the building sector of the construction industry. As a result, the

Table 1 Common barriers to the adoption of smart building concept

N/S	Categories	Barriers	Number of times barrier is reported
<i>Economy-Related</i>			
1		Delays of procurement requirements	4
2		high cost of initial construction	10
3		Long payback periods from adopting the smart building concept	12
4		Higher cost of smart building technologies	12
5		Adoption of a smart building is time-consuming and causes project delays	3
6		Lack of interest from clients and market demand	5
7		High cost of smart building equipment	1
8		Lack of financing schemes	11
<i>Government-Related</i>			
1		Lack of framework	6
2		Lack of Government incentives and policy	12
3		Lack of local institutes and facilities for research and development of smart building technologies	5
4		Lack of promotion of smart building practice	6
5		Risk and uncertainties involved in implementing new technologies	4
5		Limited procurement method of a smart building	2
<i>Technical-Related</i>			
1		Failure of electric power supply	3
2		Lack of knowledge on the smart building by contractors and professionals,	11
3		Lack of awareness of professionals and clients	8
4		Lack of technical and clear understanding of smart building by professionals, clients, and sub-contractors	2
5		Extension of project schedules	3

(continued)

Table 1 (continued)

N/S	Categories	Barriers	Number of times barrier is reported
6		Unfamiliarity with smart building technology	6
7		Lack of smart building databases and information	8
8		Risk and uncertainties involved in implementing new technologies	9
<i>Social-Human-Related</i>			
1		Lack of expressed interest from the public	3
2		Lack of awareness of clients and professionals	3
3		Lack of well-trained labour	6
4		lack of integrated work environment among professionals	5
5		Resistance to change from the use of traditional technologies	10
6		Limited procurement method of a smart building	8
7		Aesthetically less pleasing	1
8		Lack of importance attached to the smart building by senior management	3
9		Risks and uncertainties involved in adopting new technologies	10
10		Lack of poor maintenance culture	2

government is in charge of developing an effective smart building concept policy framework. As a result, this study contributes to the understanding of barriers to smart building concept adoption by identifying the most commonly reported barriers in the literature, which can be linked to a global perspective in finding, creating better insight and understanding for professionals and government on what is preventing the adoption of smart building concepts in the building sector of the construction industry.

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