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GREEN BUILDING: AN ANTIDOTE TO SICK BUILDING SYNDROME MENACE IN AFRICA

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Abstract

Sick building syndrome (SBS) is the leading cause of the reduction in the building's occupancy level of satisfaction, poor indoor air quality, and other shenanigans responsible for the underperformance of building occupants and loss in property value. Thus, this study proposed adopting green building (GB) as an antidote for reducing the causes of SBS. The challenges impeding the adoption of GB as an antidote for SBS were also examined in this study. The methodology adopted in this study was broken down into three-phase, with the first phase focused on the data collection. The study adopted a random sampling in collecting data (questionnaire) from construction stakeholders within the study area. A total of one hundred and twenty (120) questionnaires were collected from the respondents within the study area. The questionnaire was analysed using SPSS V 24, adopting frequency distribution, mean score, principal component analysis, and multiple regression analysis. The causes of SBS are divided into the ambience and individual-related factors. The findings from the multiple regression analysis revealed that green building (GB) has a higher chance of functioning as an antidote for eliminating the ambiance-related factors. Unfortunately, factors such as insufficient technical knowledge of green building components, green building occupants' behaviour, and maintenance/construction cost hinder the adoption of GB as an antidote for SBS. This study contributed to creating innovative ways towards eliminating SBS in Africa. The article presented a two-way directional framework that reveals the solution and challenges for adopting green building (GB) as an antidote for sick building syndrome (SBS). Numerous articles have identified the causes of SBS, but there is a shortage in the literature regarding a suitable solution or antidote for eliminating the specific cause of SBS.

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1. Introduction

The relationship between buildings and occupant health has been a significant concern for built environment specialists and health practitioners. In support of the affirmation, [9] affirmed that the connection or association between building occupants and their health condition is the most significant relationship. The relationship became substantial and widespread in the early '90s owing to the rising epidemic caused by overpopulation and a flawed sanitary system in buildings [17]. [3] believed that the health illness suffered by building occupants was the primary driver of the relationship between buildings and their occupants. Thus, it can be implied that individuals can suffer health challenges due to their location in a particular building.

Aside from health challenges, [33] discovered that building inhabitants can also suffer low productivity due to the nature of their building. [24] confirmed that the low productivity of workers is a function of their building. Furthermore, [41] asserted that there is an interaction between health and the built environment. The interaction is responsible for the health discomfort such as respiratory, mental, cardiovascular, and other health challenges confronting building occupants. [14] related the health discomfort facing individuals in their building to symptoms of sick building syndrome (SBS).

[40] describe sick building syndrome as a scenario in which building inhabitants experience poor health and discomfort, with such discomfort dissipating after leaving the building. [7] provided an elaborate opinion of SBS and described it as a group of symptoms ranging from headaches, cold, eyes, nose, and throat soreness suffered by an individual working or living in a building. Thus, it can be implied that the unique phenomenon of SBS is the ability to occur within a building. The uniqueness of SBS has been a bone of contention as it is often regarded as meaning the same thing as building-related diseases. [35] assisted in differentiating the two and comparing sick building syndrome with building-related diseases. [38] and [25] opined that building-related diseases are health challenges transferred from one building occupant to another. In comparison, SBS occurs owing to the defect within the building or maintenance functions of the building.

However, [16] disagreed that the defect within the building is not the only factor responsible for the occurrence of SBS. The author indicated that the accumulation of toxins, volatile organic compounds, or pollutants in the interior environment is also responsible for SBS. [3] argued that symptoms of SBS are typically caused by poor indoor ventilation. [24] opined that inadequate heating, ventilation, and air conditioning systems are some of the significant drivers of SBS. [8] demonstrated a causal link between building moisture and residents' respiratory health. Their findings indicated that various variables could contribute to the health effects of buildings on their residents. Regardless of the factors responsible for SBS [17] affirmed that it is a menace responsible for poor indoor air quality and discomfort to occupants.

Towards curbing the menace of SBS, different strategies and principles has been proposed by numerous scholars. [16] proposed the adoption of regular fumigation of the building and its surroundings. Some scholars like [25] and [23] suggested diverse strategies for combating or alleviating the impact of SBS on building occupants. The process ranges from properly designing ventilation systems, re-modeling of existing buildings, reduction of dampness, and others. Unfortunately, all the strategies have failed to eradicate sick building syndrome symptoms. The failed strategies created a gap in study regarding innovative ideas for reducing SBS symptoms. In eliminating the gap in research and practice, this study proposed adopting green building as an antidote for sick building syndrome in Africa. Green building was proposed after recognising the therapeutic effect of green materials and components [3]. [9] affirmed that green buildings have the potential to support a healthier lifestyle and low carbon emissions. Therefore, this study examines the factors impeding the utilisation of green buildings as an antidote for SBS syndrome. The impact or chances of green building functioning as an antidote for eliminating the causes of SBS was also examined. The study contributes to practice and research by providing a framework for utilising green building as an antidote to alleviating the causes of SBS.

2. Green Building

The development and construction of green buildings have recently attracted numerous researchers and practitioners. However, [24] indicated that Green buildings had existed since the beginning of time when humans first learned how to build. Green buildings have a long history dating back to the caveman period when cave inhabitants used ecologically friendly materials and built their houses to fit the surroundings. Likewise, [32] submitted that green building originated from early construction methods focused on environmentally friendly materials in the nineteenth century. Ever since, green building has experienced tremendous growth as a vital tool to eliminate the negative impact of human activities on the environment [37].

Green building reduces the negative impacts of human activities on the built environment directly and indirectly. It impacts the built environment directly at the individual level by providing optimised indoor environment quality [12]. It indirectly affects the population level by reducing energy use and air pollutants. Unfortunately, most green building studies have only focused on one aspect (pollution level) while neglecting its impact on the indoor environment quality [3]. A few once, like [41], [37], and [13], only focused on green building occupants' satisfaction with indoor environmental quality while neglecting its impact on sick building syndrome. The absence of studies related to the effect of green building in eliminating SBS could be associated with the different challenges affecting green building development, as shown in Table 1.

Table 1. Challenges in the development of green buildings

Source	Challenges of developing green building
Miller et al. (2009) and Sichali and Banda (2017)	Lack of awareness and technical know how.
Steinemann et al. (2017)	Higher cost for sustainable options.
Pioppi et al. (2020)	Insufficient supply of green product and high cost of construction.
Cedeño-Laurent et al. (2018)	Legislative support and government commitment.
Dwaikat and Ali (2016)	Uncooperative attitude of building occupants to green materials
Olubunmi et al. (2016)	Lack of green building evaluation system
Saleh et al. (2020)	Poor data management system
Chegut et al. (2019)	Procurement cost and high design fees
Pioppi et al. (2020)	Difficulty in integrating sustainable materials into occupants' lifestyle
Cedeño-Laurent et al. (2018)	Lack of manufacturers support, population growth and rapid urbanisation.

Table 1 presents the possible challenges affecting the development, construction, and management of green buildings worldwide. Despite the different challenges confronting the development of green buildings, [9] affirmed that green buildings have served as the primary driver of sustainability in the built environment. [37] indicated that ensuring sustainability in the built environment has become paramount owing to the rapid urbanisation and population that lead to extensive use of natural resources contributing to the greenhouse gas emission from new buildings. [32] discovered that green buildings contribute to sustainability by harmonizing indoor environmental quality and reducing greenhouse gas emissions. Also, the literature review revealed that most studies on green building focused on indoor environmental quality while neglecting its impact on eliminating sick building syndrome.

2.1. Sick Building Syndrome (SBS) and Green Building

The term SBS describes a situation in which building occupants are confronted with severe health discomfort related to the time spent in a building [20]. Sick building syndrome (SBS) is a complication affecting building occupants' health and skin. The complication is experienced in the form of headache, fatigue, and irritation in the upper respiratory throat, eyes, and nose [7]. [35] attributed SBS symptoms to individual risk factors like anxiety and stress, smoking, and lack of communication in working in a building. [16] examined the causes of SBS from another perspective and concluded that the COVID-19 outbreak caused it. The scholar believed that during the outbreak, the stay-at-home order increased building occupants leading to increased indoor air pollution due to more indoor activity. Thus, it can be deduced from the review of literatures that SBS is driven by certain crucial factors.

Regardless of the factors responsible for SBS [18] affirmed that there are different skeptics regarding the validity of the diagnosis of sick building syndrome. One of them emanates from the name as some scholars find it confusing because the building inhabitants suffer the symptoms, not the building. Therefore, they believed it should be termed occupants sick building syndrome since the building occupants feel health discomfort. Some other scholars like [33], [14] and [8] opined that the symptoms of SBS are psychological as some of the symptoms might be imagined by the occupants due to fatigue and stress from working. Scholars like [20] and [33] argued against the notion that SBS is a psychological trauma because the symptoms disappear immediately the occupants leave the building.

Table 2. causes and remedial solutions to sick building syndrome

Source	Causes of sick building syndrome	Remedial solutions
Hosseini et al. (2020)	The stay at home order during the COVID-19 pandemic increased SBS as there was over population within the building. The poor indoor air quality was also responsible for SBS.	Use of dis-infectant and encouraging occupants to spend more time outside their building
Joshi (2008)	Poor maintenance of the HVAC unit that in return lead to the growth of legionella organisms.	Maintenance and retrofitting
Ghaffarianhoseini et al. (2018)	There is no specific cause of SBS but it can be related to the design, maintenance and space optimisation within the building	Re-modelling the entire building
Jafari et al. (2015)	The major contributors of SBS were recycling of air in rooms using fan coils, traffic noise, poor lighting and buildings located in a polluted metropolitan area.	Introduction of building sensors to automatically control the indoor air quality.
Runeson-Broberg and Norbäck (2013)	Poor immune system of building occupants, poor air quality and low social support at work.	Create an enabling working environment
Lu et al. (2016)	Frequent exposure of occupants to building components infested with moulds, fungi and mites. Poor ventilation and light illumination into the building.	Re-design of the ventilation system.
Ismaeel et al. (2022)	Monotonous work environment and poor organisation of the workspace	Renovation

Source: author's review of literature

Table 2 presents the different causes and remedial solutions for sick building syndrome. The article was extracted from Scopus and the web of science database. Articles with the highest citation which focused on examining the causes and proposing possible remedial solutions were selected. The analysis from the article revealed that the significant factors responsible or causing sick building syndrome can be classified into individual and ambience-related factors. The individual-related factors can be attributed to the stress and the work condition of building occupants. [14] and [6] discovered that individual-related factors like occupants' history of atopy, genetic disorders, and low work status contribute to the SBS affecting building occupants. In comparison, the ambience-related factor is attributed to the building components and the indoor environmental quality.

Ambience related factors has been the major causes of sick building syndrome [14], [20], [7]. [20] affirmed that ambience related factor usually occurs inform of legionnaire's disease owing to the contamination of cooling towers by legionella organisms. [22] avowed that legionnaire's disease had been the major pollutant of the indoor environmental quality responsible for SBS. Furthermore, [40] discovered that poor air quality, air pollution, air conditioning pollution, and insufficient thermal comfort are the main drivers of ambience related factors of SBS. The risk factors or drivers are pollutants, including particulate matter (PM2.5 and PM10) generated by heating, cooking, and smoking. [26] provided another risk factors:volatile organic compounds like formaldehyde, carbon dioxide, and other air pollutants.

This study proposed the adoption of green building materials as an antidote to the risk factors responsible for the risk factors triggering SBS. This assertion was also submitted by similar studies like [15] and [37] that discovered the susceptibility of green building materials or components to fungi and bacteria growth. Green building components are labeled green based on their ability to minimize chemical emissions, are less toxic, and are recyclable [13]. The use of green building components is becoming popular for in-home users because they can prevent health risks to building occupants and impede fungal growth [41], [11]. Aside from eliminating the fungal and other bacterial growth green building also support cross ventilation which assists in reducing SBS [28] and [34]. Despite the potential of GB in eliminating the causes of SBS there seems to be a gap in literature concerning the proposition of GB as an antidote for SBS.

3. Methodology

This study evaluated the challenges hindering the adoption of green building as an antidote for sick building syndrome in Africa. The impact of green building components on eliminating the ambience and individual related factors was also appraised. A quantitative research methodology was adopted due to its capacity to effectively compare the findings between existing studies and past studies [2]. [10] provided another justification for adopting quantitative research. The scholar indicated that quantitative analysis supports comparing findings to existing theories and facts. Since this study would compare the results with the current theories related to green buildings and SBS this therefore makes quantitative methodology suitable for this study.

The data for the quantitative methodology was collected using a random sampling technique. The respondents were drawn randomly from construction professionals and project managers within Gauteng Province, South Africa. This study picked Gauteng province out of the other eight provinces in the country because the province has a higher number of construction project managers and buildings than other provinces [29]. A questionnaire was used to collect data from the construction project managers and other stakeholders. The questionnaire was broken down into three sections. The first section examines the personal characteristics of the respondents. The second section appraises the challenges of using a green building as an antidote for SBS. At the same time, the third section of the questionnaire focussed on examining the features of green building could potentially eliminate SBS.

The variables used for developing the questionnaire were sourced from the review of extant literature related to the subject matter. One hundred and fifty (150) questionnaires were distributed to the respondents randomly, but only a hundred and twenty (120) were used for the analysis after checking their consistency. The questionnaire was analysed using a statistical package for social science (SPSS V24) and adopted statistical tests like frequency, mean item score, and principal component analysis. Descriptive statistics like frequency and mean item score was used to analyse the questionnaire's first section (respondents' personal information). The respondents' personal information findings revealed that all the respondents are educated, with 47% possessing a BSc or BTech degree as their highest qualification. The remaining proportion of the respondents has either MSc or Ph.D. as their highest degree. Analysis of the personal information showed that all the respondents have an ample working experience in the management and construction of green buildings. Therefore, their response will be crucial to determining the challenges and efficiency of using a green building as an antidote to the prevention of sick building syndrome.

Principal component analysis (PCA) was used in analysing the challenges or factors hindering the adoption of green buildings as an antidote to SBS. According to [19] PCA function as a statistical tool that supports the reduction of dimensions from factors into meaningful components. Also, [5] indicated that PCA is suitable for multifaceted data or factors with numerous components. [12] opined that the challenges affecting the development of green buildings are multifaceted and therefore requires the use of PCA. The PCA was also used to break the factors or challenges hindering the adoption of green building into meaningful components. Before conducting the PCA the reliability of the data was determined using a Cronbach Alpha test. The Cronbach Alpha gave a value of 0.846 which is above the recommended threshold of 0.7 [39]. Whereas multiple regression analysis was used in examining the impact of GB component in eliminating SBS.

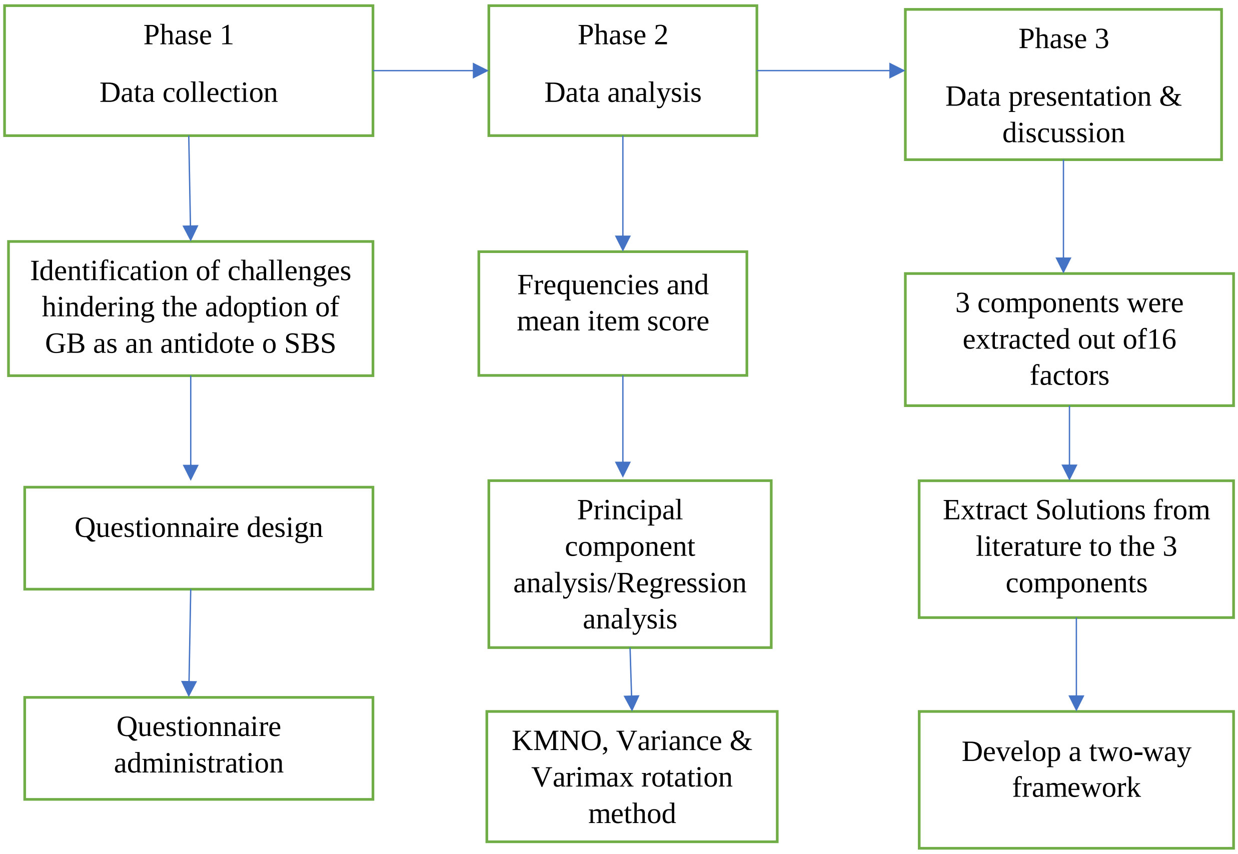

Figure 1: Research methodology framework

Source: author's review of literature

Figure 1 provides a summary of the methodology adopted in this study. The figure showed that the methodology was divided into three phases. Each phase has a minimum of three steps, and the first and second phase (data collection and analysis) have been described extensively in the previous paragraph. Figure 1 revealed that phase 3 (data presentation &discussion) of the research methodology framework is broken down into three steps. The first step involves breaking down the challenges or factors impeding the adoption of GB as an antidote of SBS into meaning dimensions or components. The solutions to the challenges were extracted from the literature, and in-return was, used to develop a two-way directional framework.

4. Discussion of Findings

This section presents the discussion of findings emanating from the analysis of the questionnaire that was distributed to the respondents. The discussion focused on the study's primary objectives: the challenges and impact of green building features in eliminating or reducing sick building syndrome.

4.1. Challenges in adopting green building as an antidote to SBS

The challenges preventing the adoption of green building as an antidote for SBS was analysed in this section. [12] affirmed that the challenges affecting the development of green buildings are multifaceted and therefore require the adoption of multifaceted statistics. This study adopted a principal component analysis (PCA) which is a multifaceted statistic. The challenges hindering green building adoption as an antidote were extracted from literature and then subjected to PCA using SPSS software. The findings from the PCA was broken down into two stages with the first stage used for checking the suitability of the data for PCA. The second stage was used to identify the component preventing the adoption of green buildings as an antidote to SBS.

Table 3. KMNO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.748
Bartlett's Test of Sphericity:		
	Approx. Chi-square	1745.364
	Degree of freedom	182
	Significant level	0.000

To determine the suitability (first stage of analysis) of data for principal component analysis, the KMNO and Bartlett's test of sphericity was conducted. The findings from the test were presented by Table 3. The findings from the analysis revealed that the KMNO gave a value of 0.748 which is higher than the recommended threshold of 0.40. According to [19] a KMNO value above 0.40 indicates that the data is suitable for component analysis. The chi-square value in Table 3 gave a significant value (1745.364) at 182 degrees of freedom. It can be confirmed from the KMNO and Bartlett test that the data collected is suitable for principal component analysis.

The second stage entails using the varimax rotation method for grouping the factors that prevent adopting green building as an antidote for SBS into different components. The findings from the varimax rotation revealed that the factors hindering the adoption of green building as an antidote for SBS is made up of three components and are presented in Table 4. The elements in each component, as shown in Table 4 were arranged according to the loadings for each factor.

Table 4. Rotated component matrix

	Component			Variance
	1	2	3	
High cost of green materials	0.843			
Procurement cost	0.829			
Cost of construction	0.800			**37.8%**
Maintenance cost	0.765			
Operating cost	0.674			
Design fees	0.600			
Low technical knowledge		0.760		
Lack of understanding on the therapeutic healing properties of green buildings		0.742		
Lack of investors' interest in green buildings		0.700		
Legislative support from the government		0.672		**15.1%**
Lack of green building maintenance staff		0.628		
Lack of manufacturers' support		0.500		
Occupants' lackadaisical behaviour toward green features			0.862	
The uncooperative attitude of building occupants to green materials			0.840	
Difficulty in integrating sustainable materials into the occupant's lifestyle			0.794	**10.5%**
The unfamiliarity of building occupants to green materials			0.700	

First component: Maintenance and Construction Cost

The first component had six variables; the topmost variables were the high cost of green materials, procurement cost, cost of construction, maintenance cost, and operating cost. All the factors with the component were related and had a variance of 37%. According to [30] and [19], the name given to a component is dependent on the variables within the component. Therefore, this component was called maintenance and construction cost. The component also accounts for a variance of 37.8% in hindering the adoption of green building as an antidote for reducing SBS. [12] also found a similar finding, who affirmed that perceived higher upfront cost accruing to green building construction by building owners and investors hinders its development.

Despite the benefit of green building in boosting the health and productivity of building occupants. [42] discovered that green building maintenance and construction cast a shadow on its benefit. Poor maintenance affects building occupants in the long term because poorly maintained buildings would impact operation cost and its occupants' social and environmental well-being [30]. Towards addressing the maintenance challenges of green buildings [43] made a case for adopting sustainable maintenance for green buildings. The maintenance system that meets the present users’ value system without compromising the value system of future users’ is known as sustainable maintenance [27]. Therefore, this study proposes the adoption of sustainable maintenance to reduce the maintenance cost attributed to using a green building as an antidote for SBS.

Second component: Low technical knowledge of green building components

The second component gave a variance of 15.1%, which implies that this component is responsible for approximately 15% of problems hindering the adoption of green buildings as an antidote for SBS. The component was listed in Table 4 and shows that the variables have a strong relationship with each other with a variable loading of 0.760 to 0.500. The component comprises of variables like low technical knowledge, lack of understanding on therapeutic healing, lack of investors, and legislative support from the government. The variables within the components were the deciding factor in naming the components. Since the variables within the components focus on the knowledge of green building components, it was called low technical knowledge of green building components. [36] affirmed that poor awareness regarding the therapeutic healing of green building features had prevented its adoption for serving as a healing material. Similarly, [34] discovered that low technical know-how and knowledge regarding green building features had hindered its adoption.

[43] submitted that the performance of a green building is dependent on the component within the structure. Similarly, [17] opined that the relationship between building and health is dependent on the occupant's knowledge of the building components. [3] avowed that occupant's awareness of green building components is often tedious owing to the numerous technologies embedded in green buildings. Towards increasing the knowledge of green building occupants with the components or technologies within the building [21] introduced the concept of beneficiary satisfaction. Although, this concept (beneficiary participation) was first introduced in housing satisfaction studies [1] and [31]. Beneficiary satisfaction allows building occupants involvement with the development and maintenance of building features. This, in return, increases their awareness of the functions of different facilities attached to the green building [21].

Third component: Occupants behaviour

The third component is responsible for 10.5% variance change in the challenges affecting the adoption of green building as an antidote for sick building syndrome. The third component in Table 4 has variables like occupants' lackadaisical behaviour, uncooperative attitude of building occupants to green materials, and difficulty integrating sustainable materials into the occupant's lifestyle. Therefore, this component was called green building occupants' behaviour. A similar study was conducted by [32], who discovered that green building energy efficiency largely depends on the occupant's behaviour.

Occupants' behaviour was described in this study as the attitude or interaction of green building occupants with the building control systems. Similarly, Chen et al (4), in their research, describe occupant behaviour as the visible action or reaction undertaken with the aim of adapting to their environmental conditions. The occupant's response to their environment could be positive or negative depending on their understanding of the environment [4], [21]. To ensure a positive reaction from the building occupants, Laaroussi et al. (2019) [suggested including the building occupant as part of the problem and solution to the problem. Although it might be confusing thus [21] affirmed that occupants' behaviour can be enhanced by creating awareness and incentives for using green building components.

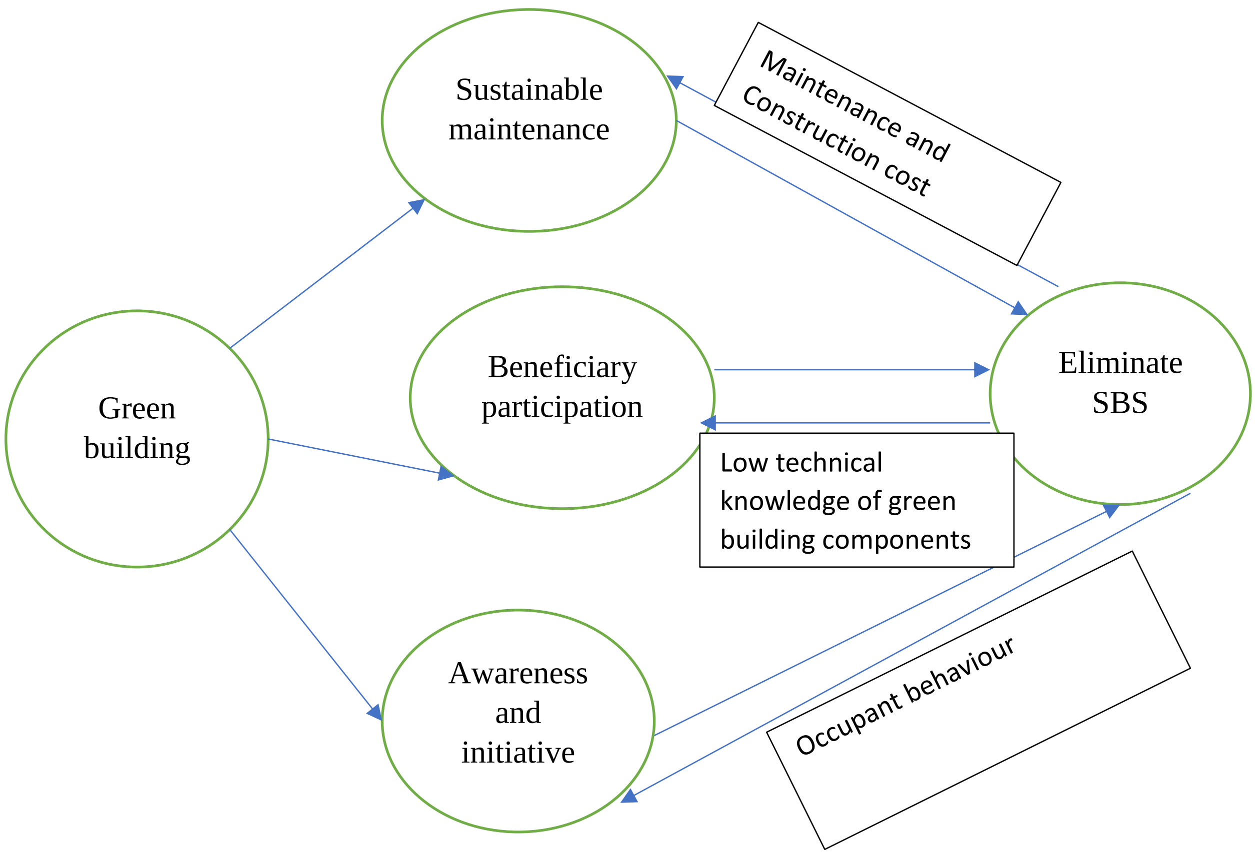

Figure 2: Two-way directional framework for green building as an antidote for SBS

Source: authors review of literature

Figure 2 presents the framework supporting the adoption of green building as an antidote for sick building syndrome (SBS). The framework is divided into two directions called the forward and the backward. This study's objective was to generate the backward (challenges in adopting green building as an antidote to SBS). In comparison, the forward direction provided the solutions to the challenges preventing the adoption of green building as an antidote for SBS. The forward direction was extracted from the review of literatures related to the challenges. Figure 2 revealed that sustainable maintenance, beneficiary participation, and awareness/initiative are the major solutions to adopting green building as an antidote to SBS. It can also be implied that the solutions (forward direction) are the major drivers for adopting green building as an antidote for SBS. Also, the occupant behaviour, low technical knowledge of green building components, and maintenance cost will hinder the adoption of green building as an antidote to SBS.

4.2. Impact of green building materials in eliminating or reducing sick building syndrome

This sub-section presents the impact of green building (GB) materials or components on eliminating the causes of SBS. The impact was determined using multiple regression analysis. The GB components were extracted from literature like [15], [11], and [32] and compressed using a computing function on SPSS into a dummy variable and function as the dependent variable. The causes of SBS were divided into ambience and individual-related factors and used as the independent factor. According to [6] the individual-related factors emanate from building occupant's personal characteristics like their work condition and stress. In comparison, the ambience-related factors are the risk or factors that pollute the indoor environmental quality [26].

Table 5. Multiple regression analysis as an antidote for reducing the causes of SBS

	B	Std.Error	t	Sig	R
Constant	.731	.216	3.384	.000	
Ambience related factor	.561	.157	4.573	.000	**0.628**
Individual related factors	.497	.237	2.097	.004	

Table 5 presents the output from the multiple regression analysis, revealing a significant effect of the green building component in reducing the causes of SBS (ambience and individual-related factors). The t-test gave a positive value for both the ambience and related factors but the ambience factors gave a higher t-test score. This implies that green building has a higher impact on reducing ambience-related factors. Likewise, [11] and [6] opined that optimising the indoor environmental quality through green labelled material can eliminate the risk factors responsible for SBS. [9] Also confirmed that optimisation of the indoor environmental air quality is vital in reducing SBS. The low impact of the GB component on individual-related factors could be attributed to the subjective nature of individual-related factors. Likewise, [33], and [8] opined that the occupants might imagine the individual-related symptoms due to fatigue and stress from working within the building. The value of R greater than 0.4 further confirms that the green building components has the potential for reducing the ambience and individual related factors.

5. Conclusion and Recommendation

The world health organizations, researchers, and industry practitioners have provided numerous opinions or definitions regarding sick-building syndrome (SBS) since the early 80s. It is commonly defined as a malady affecting the proportion of people within a building. It is also regarded as a global health menace to the health and well-being of building occupants. SBS symptoms, including but not limited to headache, fatigue and irritation in the upper respiratory throat, eyes, and nose, have been extensively researched in literature. The symptoms have been attributed to individual risk factors like anxiety and stress, smoking, and lack of communication in working in a building. Although, the findings from modern literature revealed that the stay-at-home order issued by the Government during the COVID-19 pandemic further increased the SBS. The order increases the number of occupants within the building, leading to an increase in indoor air pollution due to more indoor activity.

Sick building syndrome thrives within a building with poor indoor environmental quality; therefore, finding a lasting solution to the causes of SBS in the post-COVID-19 world became paramount. Evidence from literature revealed that SBS is the leading cause of the reduction in the building's occupancy level of satisfaction, poor indoor air quality, and other vices responsible for the underperformance of building occupants and loss in property value. To alleviate the impact of SBS, different strategies have been suggested by researchers and practitioners, ranging from the proper design of ventilation systems, re-modelling of existing buildings, reduction of dampness and others. Unfortunately, all the strategies have failed to eradicate the causes or symptoms of sick building syndrome. The failed strategies created a gap in study regarding innovative ideas in reducing SBS symptoms. To fill the gap, this study proposed adopting green building as an antidote for reducing the symptoms and causes of SBS.

The findings from the literature revealed that the causes of SBS are divided into individual and ambience-related factors. The individual-related factors are causes that are personal or related to the living or working conditions. Thus, the individual related factors include occupants' history of atopy, genetic disorders, and working/living conditions. The individual related factors vary from individual to individual. It was discovered that the individual-related factor is subjective, and thus building occupants may experience different symptoms. The subjective nature of the individual-related factor is responsible for the difficulty in finding a permanent solution to SBS. In contrast, the ambience-related factor is attributed to the building components and indoor environmental quality. The majority of the symptoms of SBS originate from the ambience-related factors which are difficult to eliminate permanently.

This study assisted in redefining the ideas for eliminating the cause and triggering factors responsible for SBS through introducing green building components into conventional buildings. Green building component has been known for their therapeutic healing effects on building occupants. Thus, this study proposed adopting green building as an antidote to eliminate the causes of sick building syndrome. This was proposed after discovering that green building can potentially reduce the negative impacts of human activities on the built environment directly and indirectly. It impacts the built environment directly at the individual level by providing optimised indoor environment quality. The regression analysis findings discovered a significant impact of green building component in serving as an antidote for alleviating the causes of SBS. The antidote will effectively eliminate the ambience-related factor more than the individual related factors.

Despite the efficiency of green building in eliminating the causes of SBS, the application is hindered by low technical knowledge of green building components, green building occupants' behaviour and maintenance and construction cost. This study contributed to creating innovative ways to curb SBS in Africa. The study recommended that awareness be created regarding green buildings' benefit and therapeutic healing potential. The study also recommended that facility managers or construction managers should involve building occupants in designing and installing green building components. The study contributes to research by providing a framework for utilising green building as an antidote to ameliorate the causes of SBS. The study contributes to practice, especially among green building investors, by providing factors that can hinder the adoption of green building developments. An area of further study can be conducted on validating the framework that was developed in this study.

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