Establishing the limitations of sustainable construction in developing countries: A systematic literature review using PRISMA.

ABSTRACT

Purpose: Establishing a more sustainable built environment is an increasing global concern for the construction industry. Despite the intrinsic and extrinsic obstacles faced by the stakeholders, huge efforts are required to transition to a smooth, sustainable construction (SC) practice. This study identifies and discusses cogent obstacles to SC in developing nations.

Design/Methodology/approach: The Preferred Reporting Item for systematic reviews and Meta-Analysis (PRISMA) approach was employed to establish research work in sustainable construction for developing countries. The databases used were Scopus and Web of Science. Meta-analysis of keywords was analysed thematically. The initial broad search returned 8,420 publications which were filtered and reviewed in-depth to fit the aim of the study, produced only 21 relevant publications from the years 2000 to 2021.

Findings: The four identified themes of obstacles to sustainable construction in developing countries are: construction professional training and education, clients' attitudes and awareness, construction industries' culture and capacity, and Governments' regulation, policies, and economy. The key barriers identified from the meta-analysis include inadequate training and education among construction professionals, poor execution of sustainability ethics, poor populace attitude towards sustainability, poor awareness and understanding, dearth of precise data and integrated study, and inappropriate priorities about sustainability.

Originality: The originality in this study are themes drawn from MDGs and SDGs publications related to sustainable construction. Consequently, the final framework presented a holistic approach to surmounting the established limitations and aided recommendations for future studies. Thus, setting a background for developing strategies to overcome the limitations and further attain sustainable development.

Keywords: Construction industry, developing countries, sustainable construction, sustainability.

1.0 Introduction

Cambridge dictionary (2022) describes limitations as blocking movement, progression, or achievement that is prevented or made more complicated. It inhibits movement from one phase to another. Limitations are part of advancement and can prevent the accomplishment of the project. In the building industry, barriers to the successful completion of construction projects include permits or approval process, limited budget, workers and force majeure, and inclement weather. The rising cost of construction, completion delays, and sustainability issues are some of the results of these obstacles. They could be referred to as setbacks that may be overcome differently.

Sustainable development (SD) has been discussed extensively and embraced in many aspects of life. United Nations, in the document chaired by Brundtland in 1987, defined Sustainable development as the capability to make development sustainable to ascertain that the present needs

are met without compromising the future generation's capability to meet their own needs (Toriola – Coker et al., 2020). SD is designed to incorporate economic, social, social, and environmental factors to attain what is naturally possible (Emmanuel, Ibrahim & Adogbo, 2014). The phrase has been acknowledged and applied in some sectors. For instance, sustainable production, sustainably built environment, sustainable agriculture, and sustainable health practices. These sectors have recommended diverse processes to attain SD. Sustainable construction is a method that tackles the demands of the building industry. It intends to realise sustainable development (Abidin, 2010). Wu et al. (2017) considered sustainable construction as construction that gratifies the needs of sustainable developments and therefore defined it as a quest to guarantee social health and economic development whilst lowering the negative effect of construction activities on the environment.

Pearce (2005) noted that the industry had been criticised for its involvement in environmental dereliction which contradicts the philosophical stance of sustainable development. For example, Kibert (1994); Lenssen & Roodman (1995); Hill & Bowen (1997); Ofori (2000); Du Plessis (2002); Pearce (2005); Dania et al. (2007); Oko John & Emmanuel Itodo (2013) unearthed the noticeable impacts enforced on the environment by the building activities. These have emphasised the necessity for sustainable construction. Establishing a more sustainable built environment is an increasing concern for the building industry in developing and developed nations. Intensive attempts have been made and are still ongoing in the developed nations for its accomplishment. These attempts have led to laws, policies, and construction of various sustainable construction.

Although sustainable construction has demonstrated its achievement in some developed nations, the responsibility lies on the developing nations to go along. Leiserowitz et al. (2006) affirmed that SC is all-inclusive and could be challenging. Huge efforts are required from all stakeholders, but this faces intrinsic or extrinsic barriers. Intrinsic barriers are internal factors such as constrained budget, while extrinsic barriers are external factors such as extreme weather (Beatley & Boyer, 2009; Newton, 2012). These factors inhibit an effortless transition to SC practices such as installing substantial openings to provide sufficient natural light and fresh air, utilising energy-saving bulbs, and recycling or reusing building materials (Assylbekov et al., 2021; Nwokoro and Onukwube, 2015). Besides, building professionals are accountable for ascertaining that they incorporate sustainable development procedures into their practices to attain a sustainable construction (Cotgrave & Riley, 2012; Mostafavi & Doherty, 2010; Newman, Beatley, & Boyer, 2009; Newton, 2012). This notion is supported by Ifije and Aigbavboa's (2020) primary and secondary data collection affirming the imperativeness of the construction professionals in the Nigerian building industry to overcome the obstacles hindering the execution of sustainable construction.

The current trends in sustainable construction in developing countries have gravitated towards green construction practices and digitalisation. However, the typological limitation regarding the organisational construction process and the concise application of sustainable construction in the construction section has been limited. This study will, therefore, expose these limitations for future study purposes.

2.0 Methodology

This research applied the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA), first designed in 2009 with updated guidance of 2020 (Sarkis-Onofre *et al.*, 2021). PRISMA aims to support a comprehensive, transparent and complete reporting of systematic reviews for effective decision-making (Panic *et al.*, 2013; Fleming et al., 2014). The PRISMA 2020 includes elaborations and reporting on the abstract, introduction, method, results, and conclusion. As part of the methods section under PRISMA 2020, the eligibility criteria and information sources such as Scopus and Web of Science, search strategy, selection process, data collection, data items, study risks, effect measures, reporting bias statements and certainty assessment (BJM, 2021). Scopus, Web of Science databases, and Google Scholar search engines are the largest compendiums of published articles (Sarkis-Onofre *et al.*, 2021; Fleming et al., 2014; BJM, 2021). The following is the 2020 PRISMA guideline by BJM (2021):

>>>>Insert Table 1<<<<

I) Previous studies, inclusive of previous versions of reviews, were identified and reported.
II) This was followed by the identification of new studies using databases. This was achieved through Scopus and Web of Science database searches.
III) Identify new studies through other methods such as websites and search engines like Google Scholar.

>>>>Insert Figure 1<<<<

Following a structured approach, the sources were determined to be peer-reviewed publications. Searches for relevant articles were conducted using Scopus and Web of science databases. As highlighted in Figure 1, the keywords used include *"sustainability", AND "sustainable construction", AND "limitations to sustainable construction", OR "obstacles to sustainable construction", OR "sustainable development", AND "construction industry", AND "developing countries".* The exclusion criteria covered the nature of articles considered conferences, articles, and books. The search location was narrowed down to developing countries such as Nigeria, actions such as Building Information modelling and lean construction practices. This investigation examined the obstacles to implementing sustainable construction in developing countries through publications using the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA).

The advanced scholar search engine for other studies feature in Google Scholar was used to set specific search criteria. The search was limited to peer-reviewed publications written in English. The exclusion criteria of years between 2000 and 2021 were applied in the study because the Millennium Development Goals (MDGs) were aimed at years 20000 to 2015, and the Sustainable Development Goals (SDGs) cover 2015 to the present (Fehling et al., 2013; Bali et al., 2020). Developing countries have been lagging in the attainment of SDGs, and this is like those of the

MDGs. In terms of developing countries, it is highly imperative to consider the timeframe from 2000 to 2021 because of the themes of MDGs and SDGs for sustainable construction.

The abstracts of extracted relevant 21 articles were then examined to determine if the original research included data collected about any obstacles to SC. Afterwards, the full-text version of relevant articles was selected. The bibliographies of the articles consulted were combed for articles with different terminologies to obtain additional studies. Similar articles relating to sustainability in different fields were also included. Twenty-one (21) articles were obtained, reviewed, and analysed. The 21 publications were analysed by synthesising the themes and meta-data of sustainable construction in developing countries. The thematic analysis considered the research method in terms of percentages and meta-data indicators for sustainable construction in developing countries.

The first stage of the systematic review applied the general search keywords related to "sustainable construction" without any exclusion criteria identified in Figure 1 and Stage 2 of Figure 2. A combined 8,420 documents were returned across all databases. This was conducted to ensure that all duplicates across all databases noted above were removed. The duplicates found were 1 381. Further, stage 2 in Figure 2 enforced the selection criteria with the dates 2000 to 2021 and associated keywords. The refined documents after exclusion criteria were 48. An in-depth review of all documents pruned the final files relevant to the aim of the study to 21 files.

3.0 Results

This section analyses the 21 articles identified above. The methodologies adopted in these studies are shown in Table 1 and discussed below.

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Table 2 and Figure 2 illustrate that most (38.10%) of the researchers conducted questionnaire surveys. The questionnaires were administered to stakeholders in the construction industry. Similarly, literature reviews (23.81%) and mixed methods (14.29%) were employed. Case studies, surveys, focus group discussions and interviews were identified as the applicable research methods in the publications.

The researchers suggest that the building industry negatively impacts the environment (Abidin, 2010; Dania et al., 2007; Emmanuel, Ibrahim, & Adogbo, 2014) and that most building projects in developing nations are not sustainable. The sustainability of infrastructure is between moderate and high, according to the study conducted by Emmanuel et al. (2014). Some features fell below moderate, adversely affecting sustainability. These features include the release of water, standardised or grid planning and ozone layer protection (Emmanuel et al., 2014). The consequence is that the less sustainable infrastructure becomes, the more the ecosystem turns out to be dilapidated

>>>Insert Table 3 <<<

Table 3 lists the barriers to sustainable construction in Figure 2. The classification is centred on stakeholders' perspectives. Each classification is subdivided by serial number. The implications of the findings are discussed in the next section. The thematic synthesis of obstacles in Table 3 was based on specific meta-data texts pertaining to negativity, limitations, sustainable construction indicators, attitudes and perceptions.

4.0 Discussion

The phrase 'sustainable construction' (SC) usually expresses pre- and post-construction processes. Sustainable construction is defined as the efforts of the industry to attain sustainable development (Dickie and Howard, 2000). Abidin (2010) and Uchehara *et al.* (2022) also support this definition by describing it as an avenue through which the industry can achieve SD. Hill and Bowen (1997) described the SC as the maintenance and management of buildings over their lifespan purposely to reduce deconstruction waste.

Even though SC has been the focus of broad research, especially in the developed nations, only a little has been done in most developing nations, especially in Africa. Sustainable construction can also be viewed as a holistic procedure to maintain and restore coordination between natural and built environments while creating communities that support economic equity and human dignity" (Du Plessis 2002). This definition proposes an interaction between the SD ethics of environmental, economic and social that are challenging and complex to achieve for most developing nations (Serpell, Kort, & Vera, 2013; Omotayo, Danvers-Watson and Oyegoke, 2022).

The preceding definition suggests that sustainable construction takes more work for stakeholders to execute. Stakeholders include construction material manufacturers, clients, government (legislatures), professionals, planning regulatory agencies and builders. The stakeholder expects to apply their experience and knowledge to reduce waste and project costs and implement efficient maintenance strategies through decision-making and careful material selection (Shafii, Arman Ali, & Othman, 2006; Omotayo, Tan and Ekundayo, 2022). These activities align the industry with the SC agenda when deployed (Murray & Cotgrave, 2007). For instance, Building Research Establishment Environmental Assessment Methodology (BREEAM), the Green Building Rating System, Home Energy Rating System, Green Star and Leadership in Energy and Environmental Design (LEED) are assessment rating systems (ARS) designed to differentiate buildings in different nations. These tools can be used as sustainable construction measures to ensure sustainable development. Implementing SC demands an appropriate understanding of SD philosophies in building projects, lifecycles, and sustainable procedures by the stakeholder's (Hill & Bowen, 1997; Matar, Georgy, & Ibrahim, 2008).

There has been a noticeable and recent increase in infrastructure advancement and urbanisation in most developing nations. This is apparent in Africa and Asia. Nations such as Nigeria, China, Hongkong, Malaysia, Tanzania and South Africa are experiencing remarkable advancement in their building industries. Besides these advancements are the adverse environmental effects of construction. Most developing nations strive with the swift frequency of urbanisation, low skill levels, poverty, institution capacity, environmental development, weak governance, and social inequality. All these factors make development very difficult (Du Plessis, 2007; Ofori, 1998).

Research from developed nations has recognised barriers to executing sustainable construction. According to Williams and Dair (2007), stakeholders' detachment from sustainability is their research's main commonly documented obstacle. They also recognised a lack of client need,

stakeholders' incapacity to implement sustainable procedures, the exchange of one sustainability procedure for another, absence of sustainable procedures, the inadequacy of verified sustainable products/materials/systems, negligence of statutory undertakers and regulators, omission of stakeholders in the execution process, ignorant stakeholders, and inadequate proficiency to achieve sustainable procedures. Assylbekov et al. (2021) classified barriers to sustainable construction into five categories which include political, economic, sociocultural, technological, and legal barriers.

Häkkinen and Belloni (2011) also recognised guiding mechanisms, clients' knowledge, economics, process (cooperation and networking, tendering and procurement, and timing) and supporting knowledge (common language and knowledge, availability of tools and methods, innovation) as obstacles to sustainable construction. Wilson and Rezgui (2013) studied obstacles to building industry stakeholders' engagement and grouped the obstacles into three classifications. The first relays individually recognised obstacles which include mistrust in information sources, knowledge inadequacy about sustainable construction, dependence on technology, scepticism and uncertainty and resistance to change in lifestyle. The second relays to an organisation's recognised obstacles, including lack of training, time inadequacy for reflective activities and taking benefit of lessons learnt, lack of empowering initiatives, work priority and overload to accelerate current activities and tasks, and lack of knowledge and information sharing. The third relays to obstacles recognised by the industry in general, including a lack of government focus on regulation and a lack of government action. The barriers identified from the emerging themes from the interviews conducted by Daniel et al. (2018) are the domination of short-term benefit culture over life cycle benefit, ignorance of sustainability and low level of knowledge among building professionals, inadequate consideration for sustainability in the design stage, inadequate demand for sustainable process and product and absence of clear government regulation and standard on sustainable construction procedure.

Several drivers of SC have also been recognised. Pitt, Tucker, Riley, & Longden (2009) recognised the drivers to include building regulations, labelling/measurement, client awareness, planning policy and levies/taxes, client demand, investment, and financial incentives. Häkkinen and Belloni (2011) identified the advancement and implementation of processes for sustainable construction requirement management, advancement of services and concepts as drivers of SC, advancement of designers' capability and team working, advancement of client understanding of the advantages of SC and deployment of sustainable construction tools.

The abovementioned literature has recognised that SC is challenging and necessitates combined efforts of stakeholders for successful execution, especially in developing nations. It has indicated that building activities negatively impact the environment. It has identified several drivers and barriers to the execution of sustainable construction. Some of these barriers have been improved in developed nations but may remain in developing nations. It is imperative to identify the barriers challenging developing countries and how they can be alleviated to enhance an effortless transition to a sustainable construction process. This is the overall gap that this research contributes.

Mavi et al. (2021) also identify recommendations for future research in inspiration across various external and internal stakeholders, sustainability incorporation at the strategic levels of the organisations, and behavioural obstacles to sustainability incorporation instead of just technical and economic. Mjakuskina et al. (2019) identified technological features of sustainable construction, including research and development of new technologies and materials which use

raw materials, improve energy efficiency, inspire green construction, implementation innovative technologies in building regulations.

5.0 Implications of findings for sustainable construction in developing countries

The agenda of this study was to expose the typologies limiting the advancement of sustainable construction in developing countries. In achieving this aim, Figure 3 articulates the stakeholders' limitations towards sustainability resulting from their education, attitudes, training, and awareness. Their viewpoint towards sustainable construction stems from their opposition to change and unsuitable priorities. This occurs when professionals hesitate to accept innovative technologies and construction techniques for fear of incurring additional costs and time. Professional viewpoints on sustainable construction are imperative if sustainable construction is to be accomplished. Inadequate knowledge, restricted exposure, awareness and understanding of sustainable construction were also recognised and classified under awareness. Some are not just conversant with sustainable construction and its concept. For instance, Dania et al. (2013) affirmed that practising professionals in the Nigerian construction industry possessed inefficient knowledge of sustainable construction. This could be ascribed to their inadequate exposure to the concept (Nwokoro and Onukwube 2015). The knowledge of sustainable construction performs an imperative role in decision-making and could appear as a catalyst for the successful execution of sustainable construction. Inadequate client awareness of sustainable construction practices and benefits has been a major limitation in developing countries.

>>>Insert Figure 3<<<

>>>Insert Table 4<<<

Table 4 Thematised implications of the results in Table 3 and Figure 3 lead to four (4) themes. Construction professional training and education, client's attitude and awareness, construction industries' culture and capacity and governments' regulation, policies, and economy. These themes are explained below with supporting scholarly sources.

>>>Insert Figure 4<<<

The four themes constituting the constraints of sustainable construction in developing countries can be divided into engagement and external influence zone. The engagement zone comprises construction professional training and clients' attitudes and awareness. The external influence zone of sustainable development comprises construction industries, culture and capacity, and governments' regulation, policies, and economy.

5.1 Engagement: Construction professional training and education

Deficient integrated research, the ambiguity of definition, inadequate accurate data, inadequate education, and training in sustainable construction were grouped under training and education. Construction professionals in developing nations need more roles in accomplishing sustainable development. Even though younger generations are informed about sustainable construction techniques through formal education, their academic skills are yet to be tested (Abidin, 2010). Inadequate training and education were reported in almost all the literature reviewed. Wong and Yip (2004) opined that training and education in SC are uncommon due to inadequate sponsorship from employers and heavy work responsibilities. The required knowledge to enable sustainable performance has yet to be fully propagated throughout the building industry, heightened by the lack of crucial knowledge of construction design and operation (Jailani et al. 2015).

Training and education ranked second out of the ten (10) factors required for sustainable construction in the survey conducted by Nwokoro and Onukwube (2015). Dania et al. (2007) also discovered that building professionals' waste management knowledge needed improvement. Dania et al. (2007) recommended that professional bodies utilise workshops and conferences to educate active professionals while educational institutions also include sustainable construction in the professional construction curriculum. Lai and Yik (2006) also investigated the *"knowledge and perception of serving and prospective operation and maintenance practitioners in Hong Kong about sustainable buildings"*. They unfolded an inadequate understanding of sustainable construction. This signifies a clear difference between education, experience and training. Shafii et al. (2006) opined that inadequate awareness of sustainable construction, inadequate education and training in sustainable design and construction, insufficient designers / professional capacity, and various other issues as obstacles to sustainable construction in Southeast Asia.

5.2 Engagement: Clients' attitude and awareness

Clients, motivators of a good number of building projects, also perform imperative roles in the successful execution of sustainable construction. The barriers they identified emanate from inadequate awareness and attitudes to sustainable construction. Clients' requirements, Inadequate business case understanding, lack of demand, procurement issues and higher cost of sustainable construction were established in the literature reviewed and classified under clients' awareness. Findings from the literature disclosed that most clients in developing nations do not request sustainable construction for projects as they are unaware of its benefits. They seem to view sustainable construction as a costly endeavour. This is apparent from the prerequisites they conveyed to their consulting building professionals, contributing to the abovementioned procurement issues. Lack of familiarity with sustainable construction, uninformed attitude, and misplaced priorities from the public towards sustainable construction result in clients' lack of interest in sustainable construction. These are classified under the client's attitude. Nasereddin and Price (2021) developed an innovative framework to encourage project decisions that permit clients to identify the whole-life value of investing in sustainable construction.

5.3 External influence: Construction industries' culture and capacity

The construction industry in developing countries also encumbers the successful execution of sustainable construction. The impacts of the industry may be classified into the industry's capacity

and culture. Issues such as inadequate demonstration examples, industry culture, lack of coordination, and unreliable information were noted in the literature reviewed and classified under culture. These issues encumbered professionals who depend on feasible illustrations for exemplars and information. Likewise, inadequate capacity, inappropriate priorities, inadequate measurement standards, lack of proven alternative technologies, inadequate domestic materials, and higher costs of sustainable construction have been identified and classified in this category. The impacts of these issues on sustainable construction cannot be overemphasised.

For instance, inadequate measurement standard indicates an inaccurate measurement of actions considered sustainable or not (Hill & Bowen, 1997). The measurement of sustainability noted by Pitt et al. (2009) remains to be discovered. The industry depends deeply on imported materials as local, sustainable materials may be scarce unavailable, and limited. This makes sustainable construction very costly in developing nations.

5.4 External influence: Governments' regulation, policies, and economy

The position of government institutions in developing countries towards sustainable construction is imperative. The government performs an imperative role through its regulations and policies. Additionally, a favourable economic climate also enhances the execution of sustainable construction. Shafii et al. (2006) and Pitt et al. (2009) purported that construction regulatory obstacles are one of the issues that encumber sustainable construction. Furthermore, lack of implementation and monitoring of law and legislation; a lack of misplaced priorities and planning were established and classified under policies. Shafii et al. (2006) and Gan et al. (2015), infrastructure development and poverty reduction in developing nations as government concerns in achieving sustainable development. Attention is being paid to economic viability in mainland China with fewer priorities on economic feasibility and fewer on social and environmental performance (Shen et al., 2010). Lack of implementation and monitoring of law and legislation have also been recognised as obstructing sustainable construction in developing nations. Abidin (2010) suggest that in circumstances where awareness is moderate or high, execution problems exist. Nwokoro and Onukwube (2015) also identified inadequate institutional infrastructure encouraging green buildings and professional capabilities to integrate green building opportunities and issues.

Abidin (2010) stated issues that hamper wider implementation of sustainable construction: lack of knowledge, education versus experience, financial constraints, and passive culture. Karji et al. (2020) further classified the constraint into four categories, preconstruction, legislative, managerial, and planning constraints, as the industry's most significant challenges in promoting SC. Additionally, poverty and low urban investment, financial incentives, political instability, and uncertain economic environment were identified in the literature reviewed and classified under economy. These issues impact the economy and alter an effortless transition to sustainable construction.

Having acknowledged the barriers, the most important challenge industry encountered is "*finding a holistic approach to making sure that its contribution to the physical, economic and human development of these countries meets the requirements of sustainable development*" (Du Plessis, 2007). This ensues from different challenges encountered by different nations (Dania et al., 2013). As related to developed countries, the building construction industry in developing nations

encountered sustainable construction challenges (Plessis, 2001; Du Plessis, 2002; Kumaraswamy & Shrestha, 2002; Ofori, 2003; Gunhan & Arditi, 2005; Flanagan, 2005; Construction, 2008; Ofori 2012). Recognises health and safety of construction workers, international construction, climate change, population issues, environmental issues, communication and information technology, globalisation, poverty alleviation, technology innovation and development, productivity and quality and reconstruction and disaster prevention to be some of the variances between construction industries of developing and developed nations. Therefore, there is a serious and significant gap between what is presently achieved and what needs to be accomplished.

6.0 Conclusion, limitations, and recommendations for further studies

This research reviewed the literature on sustainable construction, disclosing the dominance in the developed nations with little in developing nations. Sustainable construction is also known to be challenging, requiring stakeholders' joint attempts for successful execution. The study identified thirty (30) obstacles to sustainable construction in developing nations. Clients, government, the building industry, and professionals are the barriers recognised. Clients' barriers were classified based on their awareness and attitude. Government barriers were classified based on regulations, economy, and policies. Building industry barriers were unique to the capacity and culture of the industry, while professionals' barriers were further classified relating to their attitude, education, awareness, and training. These barriers are contingent on each other, which signifies that surmounting them entails robust and complete processes. The robust, complete processes for accomplishing sustainable construction are proposed as follows:

I. The government should implement and examine existing rules and regulations to discourage defaulters.
II. The construction policies and regulations that will enhance the development of sustainable construction should be implemented. Therefore, the government must incentivise sustainable construction project owners to encourage others.
III. The building industry needs to be well managed and provide a shared basis for developing domestic or local sustainable construction materials and information exchange. In other words, the industry must invest more in studies to develop homegrown technologies for sustainable construction. This should reduce the high cost of sustainable construction materials.
IV. Professionals require education, training, and awareness of the possibilities of sustainable construction. This will motivate and position them to educate the clients who may need to be more conversant with the advantages of sustainable construction. Increasing clients' knowledge of sustainable construction will lead to high demand for sustainable construction projects.

These recommendations, if executed, offer possible solutions to the barriers encountered in executing sustainable construction in developing nations. The view of building professionals about sustainability and how sustainability can be determined could be a catalyst for further investigation. The limitations of this study are its theoretic nature without empirical quantitative or qualitative data. Further recommendations for future studies should include a longitudinal empirical study of the impact of SDGs since 2015 on developing countries and transference into

sustainable construction. Furthermore, the typologies limiting the application of sustainable construction in developing countries may be compared with developed countries for further amelioration of the challenge.

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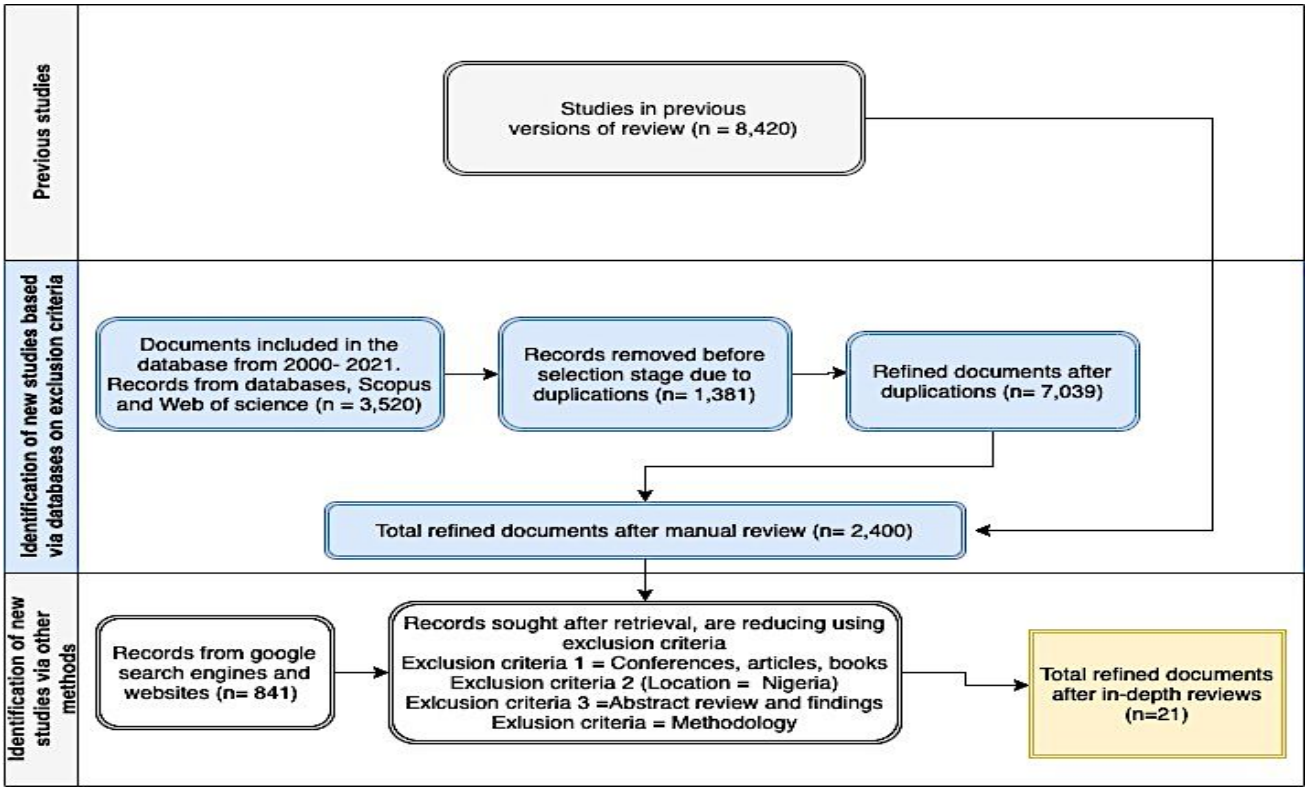

Figure 1. PRISMA 2020 protocol adapted for this study.

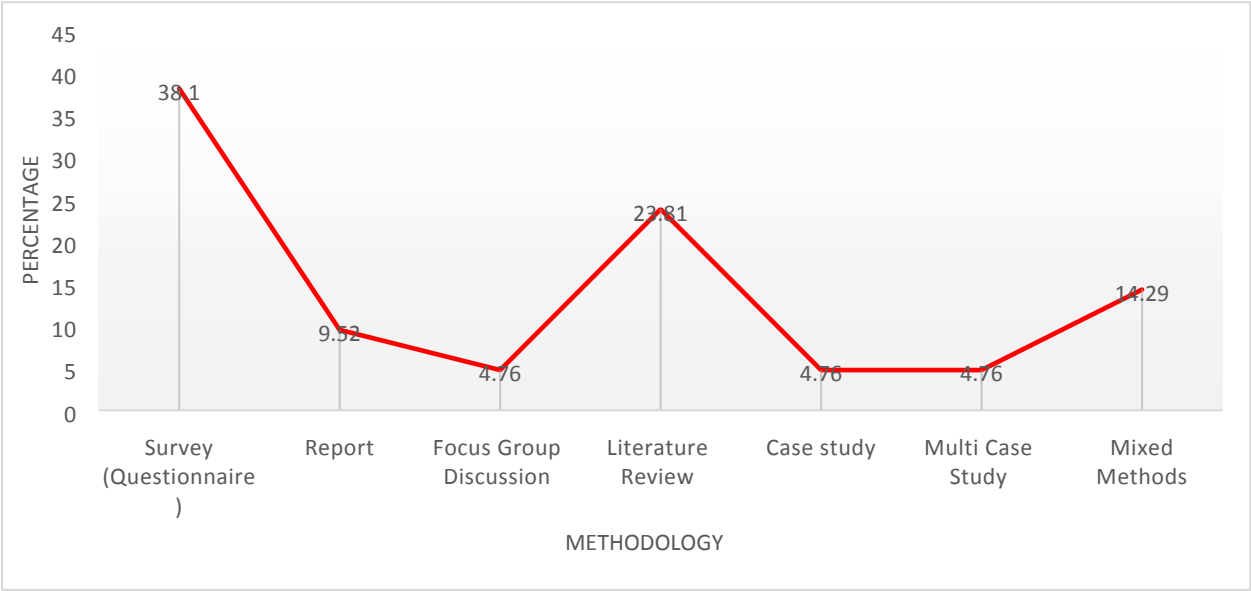

Figure 2. Percentage of methodologies adopted in sustainable construction research

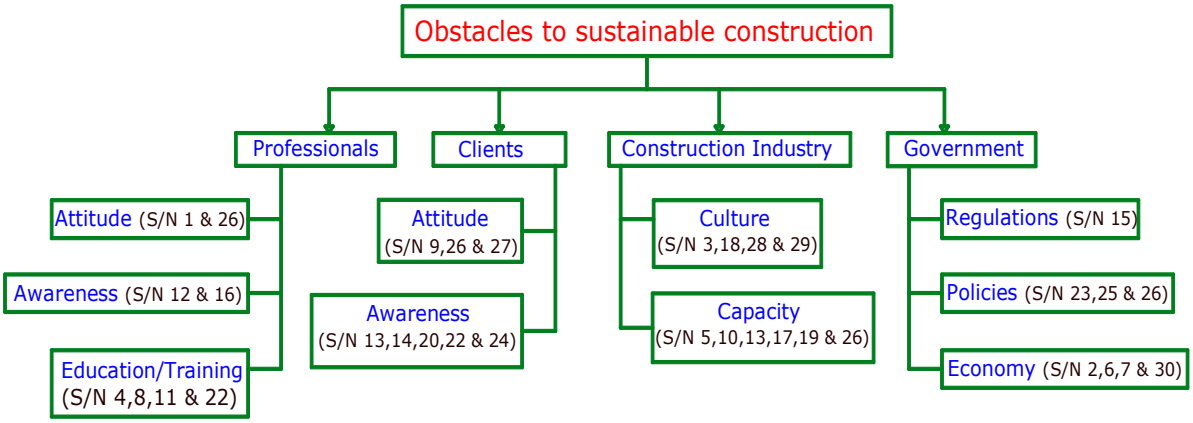

Figure 3. Limitations of sustainable construction

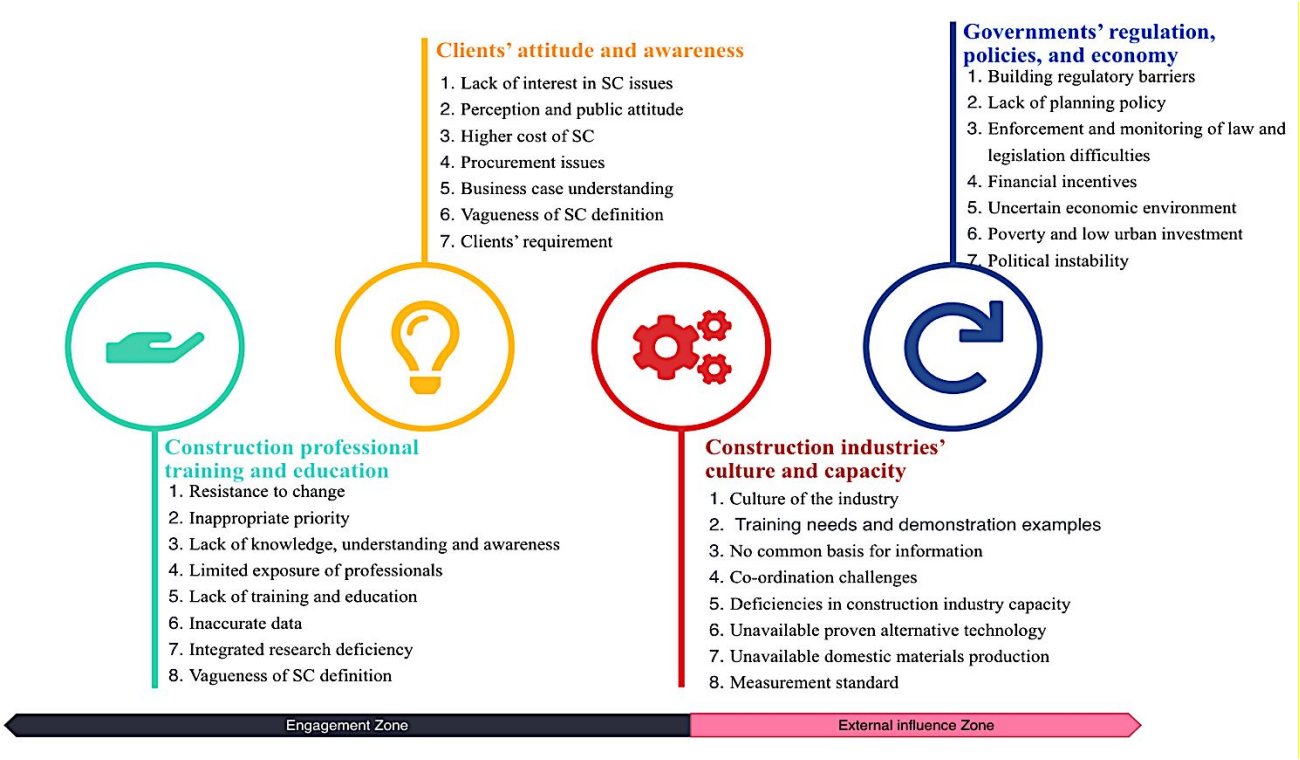

Figure 4. Highlighting the framework of sustainable construction barriers in developing countries

Table 1. PRISMA 2020 Item checklist for research method.

Methods	Approach
Eligibility criteria	Keyword search = *"sustainability", "sustainable construction", "limitations to sustainable construction", "obstacles to sustainable construction", "sustainable development", "construction industry" and "developing countries".*
Information sources	Scopus, web of science and Google scholar.
Search strategy	Exclusion criteria= include Articles, books, conferences, reports, citations, developing countries such as Nigeria, Brazil, South Africa, Malaysia etc., and a search time frame of 2000 to 2021.
Selection process	Three (3) reviewers screened the outcomes of the publications retrieved. The abstracts of the retrieved articles were reviewed manually. The worked independently and combined their findings.
Data collection process	Data from the publications were collected by manually reviewing the publications spreadsheet for the research strategy, methods, keywords, and themes on limitations of sustainable construction.
Data items	A list of all outcomes for which data were sought was recorded in a table in terms of sustainable development research about developing countries. The specified list was compatible with the outcomes of the knowledge domain.
Study risk of bias assessment	Three (3) reviewers reviewed the outcomes of the study and worked independently before combining and contrasting the outcomes of the findings. This process was used to eliminate bias.
Effect measures	The effect measures were produced using percentage values.
Synthesis methods	The tabulation of the study featured the sources for each theme of sustainable development in developing countries
	Summary statistics were presented in line graphs of percentages of research methods applied in the study.
	Meta-analysis considered the citations as a level of impact for the study.
Certainty assessment	The assessment certainty was measured through comparatives with previous studies in the field and contribution to knowledge.

Table 2: Methodology adopted in the studies

Methodology	**Frequency**	**Percentage (%)**
Survey (Questionnaire)	8	38.10
Report	2	9.52
Focus Group Discussion	1	4.76
Literature Review	5	23.81
Case study	1	4.76
Multi Case Study	1	4.76
Mixed Methods	3	14.29
Total	*21*	*100*

Table 3: limitations of sustainable construction in developing countries

Nr.	**Obstacle**	**Author(s) and year**
1.	Resistance to change	Wong and Yip (2004); Babawale and Oyalowo (2011)
2.	Financial incentives	Wong and Yip (2004)
3.	Culture of the industry	Wong and Yip (2004); Ebohon and Rwelamila (2001)
4.	Lack of training and education	Abidin (2010); Ebohon and Rwelamila (2001); Gan, Zuo, Ye, Skitmore, and Xiong (2015); Nwokoro and Onukwube (2015); Shafii et al. (2006); Wong and Yip (2004)
5.	Deficiencies in construction industry capacity	Du Plessis (2001); (Moghayedi *et al.*, 2021)
6.	Uncertain economic environment	Du Plessis (2001); Ebohon and Rwelamila (2001)
7.	Poverty and low urban investment	Du Plessis (2001)

8.	Inaccurate data	Moghayedi *et al.* (2021)
9.	Lack of interest in SC issues	Du Plessis (2001); Osobajo *et al.* (2020)
10.	Unavailable proven alternative technology	Du Plessis (2001); Pitt et al. (2009); Ebohon and Rwelamila (2001)
11.	Integrated research deficiency	Du Plessis (2001); Babawale and Oyalowo (2011)
12.	Lack of knowledge, understanding and awareness of SC	Shafii et al. (2006); Abidin (2010); A. A. Dania, Larsen, and Yao (2013); Jailani, Reed, and James (2015); Pitt et al. (2009); Dania et al. (2007)
13.	Higher cost of SC	Shafii et al. (2006) ; Pitt et al. (2009)
14.	Procurement issues	Shafii et al. (2006); Ebohon and Rwelamila (2001)
15.	Building regulatory barriers	Shafii et al. (2006); Pitt et al. (2009)
16.	Limited exposure of professionals	Shafii et al. (2006); Babawale and Oyalowo (2011)
17.	Unavailable domestic materials production	Shafii et al. (2006); Ebohon and Rwelamila (2001)
18.	Training needs and demonstration examples	Shafii et al. (2006)
19.	Measurement standard	Emmanuel et al. (2014); Pitt et al. (2009); Shen, Tam, Tam, and Ji (2010)
20.	Business case understanding	Pitt et al. (2009)
21.	Low client demand	Pitt et al. (2009); Gan et al. (2015); Abidin (2010)
22.	Vagueness of SC definition	A. A. Dania et al. (2013); Lai and Yik (2006); Du Plessis (2001)
23.	Lack of planning policy	Pitt et al. (2009)
24.	Clients' requirement	Gan et al. (2015)
25.	Enforcement and monitoring of law and legislation difficulties	Abidin (2010); Nwokoro and Onukwube (2015); Ebohon and Rwelamila (2001)

26.	Inappropriate priority	Babawale and Oyalowo (2011); Shen et al. (2010); Gan et al. (2015); Shafii et al. (2006)
27.	Perception and public attitude	Nwokoro and Onukwube (2015); Mansaray, Ajiboye, and Audu (1998)
28.	No common basis for information	Emmanuel et al. (2014); Gan et al. (2015)
29.	Co-ordination challenges	Ebohon and Rwelamila (2001); Dania et al. (2007)
30.	Political instability	Ebohon and Rwelamila (2001); Shen et al. (2010)

Table 4. Themes as drawn from the results in Figure 3

Nr.	Theme	Meta-data analysed
1	Construction professional training and education	Attitude (SN 1& 26), Awareness (SN 12 & 16), and Education and Training (S/N 4, 8, 11 & 22)
2	Clients' attitude and awareness	Attitude (S/N 9 & 27) and Awareness (S/N 13, 14, 20, 22 & 24)
3	Construction industries' culture and capacity	Culture (S/N 3, 18, 28 & 29) and Capacity (5,10, 17 &19)
4	Governments' regulation, policies, and economy	Regulations (S/N 15), Policies (S/N 23, 25 & 26) and Economy (2, 6, 7 & 30)