EVALUATION OF THE CRITICAL SUCCESS FACTORS FOR SUSTAINABLE HOUSING DELIVERY: ANALYTIC HIERARCHY PROCESS APPROACH

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Abstract

Purpose - Despite the varied housing policies guiding the Nigerian housing provision, its delivery is yet to level up with the global acceptable sustainability requirements. Previous studies revealed that developing countries are yet to unravel and embrace the tenets of sustainable housing delivery. This study, therefore, adopted the AHP survey in evaluating the Critical Success Factors (CSFs) that can enhance the delivery of sustainable housing and in turn meeting the nation sustainable housing needs.

Design/methods/approach- Data for the study was sourced from housing developers in Nigeria. A pilot survey was done to reduce the identified success factors into a manageable size. These factors were evaluated using the analytical hierarchy process to ascertain the significant factors for sustainable housing delivery in developing economies.

Findings- Findings from the study revealed that government funding towards sustainable housing, access to low-interest housing loan, mandating affordable housing development, ensuring community participation during housing delivery, the involvement of housing stakeholders, ensuring the security of life and properties, use of sustainable materials, adaptable housing design and befitting land use are the significant CSFs required for enhancing sustainable housing delivery.

Practical Implication- The findings of this study seek to inform developers, practitioners and policymakers on the CSFs crucial for sustainability attainment in the built environment

Originality/value-The CSFs are quite important and they would promote government sustainability programs, meeting housing needs and if well implemented and adopted thereby solving environmental and socio-economic challenges of traditional housing development. This research has added to the existing literature on sustainable housing delivery by providing information on inclusive CSFs that would enhance the delivery of sustainable housing in the developing economy. Further research of this nature can also be carried out to compare and contrast with other developing economies.

Paper type: Research paper

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Introduction

In any housing delivery, sustainability attainment determines its success (Yusof, *et al.*, 2013). Sustainable development is the realization of improved well-being through judicious resources usage which appreciates ceaseless social advancement while preserving stable economic development, protecting the environment and has compassion for posterity (Turcotte & Ken, 2010). Sustainable housing is one that seeks to meet the economic, environmental and social goal. It can be a house designed against hazards, meet the needs of people's choice and control, commands value and meet social and cultural priorities (UN-HABITAT, 2012). Conversely, Oyebanji *et al.,* (2017) concluded that the housing delivery

system in the developing countries, is yet to attain the sustainable development goal (SDG) requirements, that is, "making a safe, resilient and sustainable cities for human settlements". Thus, housing is the heartbeat of a sustainable development agenda and a major determinant of a better urban future (Adabre & Chan, 2019). As noted by Pinto and Covin (1989), the prime reasons for having non-sustainable housing are inability to ascertain those key result areas for successful delivery. Chan and Adabre (2019) submitted that lack of knowledge of these critical success factors (CSF's) can lead to the inability of housing delivered to be deficient of any of the three pillars of sustainable housing.

The CSF's for sustainable housing is that core aspect in which positive outcome in the delivery process is imperative for achieving a set housing goal (Oyebanji *et al.,* 2017). This CSF's is a concept developed in 1976 and was regarded as those little areas required for the attainment of a particular goal and also those areas where attention must be given to as it will yield a favourable result eventually (Rockart, 1982). These CSF's are important elements necessary for promoting continuous housing delivery success, hence they are significant areas that require attention (Ranjan & Bhatnagar 2008). The authorities in charge of housing delivery are bedevilled with problems in determining the significant CSF's necessary for sustainable housing delivery (Adabre & Chan, 2019). This has led to the inefficient decision and counterproductive policies in housing. The CSF's for sustainable housing delivery has not been well documented in African countries (Oyebanji et al., 2017; Adabre & Chan, 2019). The appropriate CSF's is often not given adequate consideration in determining the individual contributory factor in sustainable housing delivery (Chan, 2019). Regrettably, the major impediment to sustainable housing delivery is the inability of concerned authorities to understand how CSFs could support its growth and development (Oyebanji *et al.,* 2017; Adabre & Chan, 2019). Most of the studies conducted focus on the causes of housing policies failure and ignored the identification of the CSF's necessary for sustainable housing delivery. This has however posed a threat on the housing sector delivery system. Adinyira *et al.*,(2012) advocated that the non-sustainable housing delivery in developing countries has been attributed to the dearth of indisputably defined key performance indicators which should guide and assess sustainable housing delivery success.

Amao and Ilesanmi,(2013) averred that following the United Nation benchmark, Lagos being a megacity and former administrative seat of power in Nigeria, its housing provision has not fully maximized the agenda of the SDG. Choi, (2010) concluded that most developing cities, Lagos inclusive, are in the immaturity stage of sustainable housing delivery process while the delivery system of others is also in a chaotic state. Adabre and Chan, (2019) while corroborating this, asserted that effective and efficient development of the sustainable housing delivery from the infancy stage cannot be attained in isolation but requires the interaction between social, economic, and environmental success factors. This according to Ilesanmi (2010) will be possible if effective and efficient strategic plan on sustainable housing delivery CSFs that would enhance the SDG goal is formulated (Ilesanmi, 2010).

There is no universally accepted description for development success because each project especially housing is unique in its situations. A way of studying the success of a project is to pay attention to the key performance indicators for the successful delivery of sustainable housing (Gudiene *et al*., 2014). According to Garbharran *et al*. (2012), those inputs which directly influence the probability of attaining project success are termed "Critical Success Factors".

The rationale for this study rests on the fact that there exists no coherent information on the CSFs that are germane for achieving sustainable housing delivery in developing countries. The fact that Nigeria is yet to fully explore the sustainability mechanism makes the research imperative. Therefore, research on the CSFs that can aid sustainable housing delivery attainment is not out of place. The research findings would fill the gap in knowledge regarding the CSFs for sustainable housing delivery which will, in turn, provide pointers for housing providers, practitioners, developers and policymakers on the appropriate mix of CSFs for achieving sustainable housing delivery. With regards to these perspectives, the study seeks to explore the CSFs that need be adopted in developing economies to achieve sustainable housing delivery using the AHP survey thereby solving environmental and socio-economic challenges of traditional housing development and meeting future housing needs.

Housing sustainability and its requirements

Oyebanji *et al.,* (2017) pointed out that sustainable housing delivery is a program and policies designed to ensure the safe delivery of economical, safe and affordable housing for all individual in a society. According to Morgan and Talbot (2001), sustainable housing delivery has recently been the focus of housing providers during design. Chan *et al.,*(2017) submitted that housing sustainability gives room for a balanced and efficient future with simultaneous consideration of social and environmental and economic factors. Maliene and Malys (2008) averred that housing sustainability embraces economical, an ecological, aesthetical, comfortable, and cosy design which also considers not only the short and long-term housing running costs but also cost, energy, waste, and water management efficiency. Therefore, sustainable housing is an "energy-efficient" and "healthy" building which is usually planned, designed and built with attention to the social, environmental and economic indicators (Olanrewaju *et al.,*2018; Gibberd, 2002).

Housing sustainability integrates basic requirements such as affordability, durability, waste minimization, social impact, energy efficiency, indoor quality and users' friendliness Olanrewaju *et al.,* 2018). Housing construction and green building studies by (Adabre &Chan 2019; Chan *et al*., 2019; Hamid *et al*., 2018; Olanrewaju *et al.,* 2018; Oyebanji *et al.,*2017;Maliene and Malys, 2008; Chan *et al.,*2017; Winston ,2010; Fisher *et al.,*2009) noted that the requirements for housing sustainability could be summarized into three headings namely; economic requirements, social requirements and environmental requirements. Turcotte and Ken (2010) therefore concluded that most literature on housing sustainability pays attention to economic, environmental and social requirements of

sustainability. Although earlier studies submitted that technical, cultural and managerial requirements are also important in housing delivery (Ofori 1998; Hill & Bowen, 1997).

Sourani and Sohali (2005) laid the controversy to rest suggesting that housing sustainability might have different interpretations, but the integration of three main dimensions of environmental, economic and social cannot be neglected. Therefore, in any housing sector, these triple bottom line concept of sustainability remains a central requirement. The social sustainability requirements embrace the provision of social and recreation amenity, healthy internal environment, safety, and job accessibility (Hassan *et al.,* 2010; Turcotte & Ken, 2010). The economic sustainability encompasses housing affordability, cost efficiency over time, local economy and job creation (Sourani & Sohali, 2005). Environmental sustainability requirements, on the other hand, include waste management, energy and material efficiency, pollution prevention, land and water conservation, greenhouse gas emissions reduction, and biodiversity enhancement (Hassan et al., 2010; Turcotte & Ken, 2010).

Critical success factors for sustainable housing

AHP survey is a mathematical tool for decision making in multi-criteria situations (Saaty, 1980). The technique performs better than conventional multi-decision analysis methods as it does not permit numerical guess. It is a method developed for choice and prioritization (Dyer & Forman, 1992). AHP has been widely adopted in dealing with multi-criteria and complex situation related to housing and construction decision-making problems (Chan *et al*., 2009). Darko *et al,* (2018) revealed that green building and sustainable housing are the most popular built environment area where AHP applicability is more suitable. In the literature, several critical success factors list, and models have been proposed, over the past decades. Authors have submitted that to attain sustainability, there is a need to fuse appropriate CSFs into the delivery strategies. The literature categorizes them (see Table 1) into economic, social and environmental categories (Mulliner & Maliene, 2011; Oyebanji *et al.,* 2017; Adabre & Chan 2019).

Economic CSFs embraces the promotion of sustainable housing through schemes such as affordable rent, reduced mortgage interest rate, subsidized construction materials, effective use of resources use good governance (Oyebanji *et al*., 2017). Adabre and Chan (2019) affirmed that these schemes may facilitate affordable housing in the long run and promote the reputation of the countries that adopted it. Social CSFs on the other hand, encompassed key performance indicators of sustainable housing that appreciates the different characteristics of people, culture, background, household size and needs. These factors relate to social cohesion among people, lives and property security, infrastructural facilities provisions, stakeholders and community participation (Oyebanji *et al*., 2017). Accordingly, they can enhance and promote a strong and healthy community through the provision of requirements to cater for the present and the posterity needs thus enabling the creation of a sustainable built environment which supports the social values and wellbeing of the people (Oyebanji *et al.,* 2017). Housing, people and the environment are inseparable elements in the built environment. Oyebanji *et al*. (2017) noted that environmental CSF's embraces the wise

utilization of sustainable materials, minimizing its impact on the environment and yielding an optimum and best use. These factors often promote biodiversity, waste reduction and environmental pollution, thereby promoting a low carbon economy (Pattinaja & Putuhena, 2010).

Oyebanji *et al.,* (2007) investigated the CSFs for achieving sustainable social housing in England through careful examinations of the three dimensions of CSFs in sustainable housing delivery (economic, social and environmental). The study adopted a survey research design via questionnaire administration on the housing experts in England. Document content analysis was also conducted in other to identify from the literature the CSFs for sustainable housing. The study found out that affordability and mandatory inclusion of sustainable housing during delivery is the critical economic success factors from both the survey analysis and document analysis. Further findings revealed that environmental protection and provision of good road networks and alternatives are the very critical environmental factor for achieving sustainable housing. Conversely, the study also noted that to ensure social sustainability in housing delivery, the various factors include equity promotion, stakeholder's participation, property and lives security and quality housing provision. The study, therefore, suggested adequate funding, housing subsidy, adoption of relevant technology and use of materials friendly to the environment are efficient sustainable housing development strategies. Adinyira *et al.,* (2012) investigated the success factors that are critical for public housing project delivery in Ghana. The study adopted a questionnaire survey to elicit information from the experienced professionals on various success factors reviewed in the literature. The study however conducted mean item score analysis and factors analysis on the data collected. The study revealed that cost and extensive use of local materials are the important success factors for delivery housing in the study area. However, the 13 critical success criteria identified in the literature were summarized using factor analysis into 4 headings namely, health and safety of the environment; user affordability and appropriate technology are critical factors for its successful delivery. The study noted that the use of local and lasting materials to replace the foreign ones is very critical for the development of Ghana's public housing scheme. The study concluded that a comprehensive national housing policy coupled with a national housing authority who will initiate, evaluate and regulate the housing industry thus promoting sustainability in housing delivery is of importance.

Hassan *et al.*, (2010) also investigated the CSFs for sustainable housing in Malaysia. The study provided a theoretical strategy in identifying the CSFs for the management of a sustainable housing project. The study discovered that involvement of client, top management support, information and communication and the real cost is the major CSFs for delivering sustainable housing. The study however established that the identified CSFs are crucial in supporting sustainable housing. It was revealed from the work that sustainable housing is still a new thing in Malaysia hence the integration of the success factors would go a long way to achieving success. The study concludes that success in the housing project is dependent on the sustainability level achieved now and in the long run. Gudiene*, et al*., (2014) evaluated the CSF for sustainable construction in Lithuania. The study adopted the

AHP approach to examine the comparability of these factors. The study adopted a general survey for identification of the CSFs and AHP survey was further used to evaluate the CSFs. The study adopted an AHP survey based on the premise that it is very powerful and a flexible method which deploys hierarchic structure to represent complex situation by breaking them down into smaller sub-criteria. The weight of the various criteria and sub-criteria were calculated using the AHP. The study found out that appropriate planning, expertise and competence of the developer, as well as clear and achievable goals are the CSFs that influence the successful delivery of the construction.

Nurul and Khadijah (2017) examined the CSFs of housing delivery system among Malaysian developers. The findings of the study revealed that financial factors, economic and environmental factors are the CSFs for delivery housing in the study area. The study revealed that legislative power has little or nothing to do in the delivery of housing. The study revealed that housing policy and other legislative acts are not critical to housing delivery in the study area. It was concluded that financial organizations should make housing loan more accessible together with stable micro-economics in other to enable developers to deliver housing successfully. Youneszadeh *et al.,* (2017) also adopted Fuzzy Analytic Network Process (FANP) for evaluating the CSFs in urban housing. The study adopted a three-step wise evaluation process; identifying the CSFs, redefining and categorizing CSFs using the Delphi method and finally ranking the CSFs using the fuzzy network process. It was evident that the allocation of resources, on-time funding and project management team support is very significant for the successful delivery of the housing project. The study, however, concluded that the categorization could be applicable in other housing development in the developing countries.

Hamid *et al*., (2018) explored the attainment of a sustainable affordable housing scheme in Malaysia. The study examined the present situation of sustainable affordable housing implementation in Malaysia to identify the CSFs for promoting sustainable housing affordability. The study however divided the CSFs into three pillars namely economic, social and environmental so that each could be addressed holistically. The study revealed the usage of sustainable materials, befitting use of land and energy-efficient appliances are the most critical environmental success factors that must be integrated to enhance sustainable affordable housing. Furthermore, the findings revealed that the involvement of relevant stakeholders during development, social housing programs public sensitization and quality housing provision are the required social CSFs. The study also submitted that subsidy on materials, housing loans are very crucial in attaining economic sustainability. Adabre and Chan (2019) studied the CSFs for affordable and sustainable housing in Hong Kong. The study employs the questionnaire survey to solicit information from the affordable housing experts in Hong Kong. The study found out that the CSF for sustainable affordable housing includes a rational political will, formulation of effective housing policy, housing loan should be made accessible, provisions of housing subsidy, projects should be located in a good area provision of social amenities and monitoring condition of completed housing. Furthermore, the study grouped all the CSF's into the following headings; developer's incentives and

guarantee enabling CSF's, appropriate land use CSF's, and house demand enabling CSF's. It was established that proper adoption of the CSF's will enhance a comprehensive sustainable housing delivery.

Based on the literature, there exists a dearth of empirical studies on the CSFs that can aid the delivery of sustainable housing in Africa particularly in Nigeria. Conversely, despite the research on CSFs for sustainable housing delivery, only a few have attempted to examine the pairwise comparison. This study would expand knowledge related to the adoption of AHP for evaluating the CSFs for sustainable housing. The CSFs tested in this study as presented in Table 1 were derived from the review of existing literature. These inclusive factors promote housing sustainability in developed nations as suggested by the authors. However, this present research further tested these CSFs variables within the developing economy to ascertain its inclusiveness or not towards achieving sustainable housing delivery.
(INSERT TABLE I HERE)

Methodology

Identification of the CSFs

A wide literature review was carried out to identify the potential CSFs required for successful housing delivery (see Table I). In the Table, 24 CSFs that have received considerable attention in previous researches were selected.

Reliability and Validity

Before the conduction of the survey on the developers, validation, assessment and rationality of the questionnaire was carried out. This was done by practitioners and research academics from the Federal University of Technology, Akure Nigeria to review the questionnaire so as eliminate the ambiguity of expression and ensure relevant terms are used based on the peculiarity of Nigeria housing market. The questionnaire was finalized based on the feedback form. The reliability of the data was conducted yielding a Cronbach's alpha value of 0.799 for the 24 identified factors. This is a little greater than the boundary of 0.70, suggesting that a 5-point measurement scale and therefore the collected data are highly dependable for further statistical analyses.

Pilot Survey

The systematic approach of data collection for research is usually via a questionnaire survey on the selected sample (Tan, 2011). In this research, the questionnaire survey was carried out to evaluate the CSFs for enhancing sustainable housing delivery. This study involved the use of two forms of surveys (a general and the AHP). Firstly, in the literature review, a total of 24 success factors were recognized and they classified into three clusters: economic, social and environmental-related factors. The general/pilot survey was conducted on 91 real estate developers whose opinion were sought on the proposed success factors for the sustainability of housing delivery. A 5-point Likert (5– "most important" to 1– "less important") was adopted to capture the position of the success factors. In determining the relative position of

the success factors, the scores obtained were transformed to relative importance indices. The result and the CSFs ranking are presented (see Table II). The pilot survey was done to ascertain the developers (to take part in the AHP survey) with a reasonable number of years of experience in the provision of sustainable housing. The benchmark as put forward by Cheng and Li (2002) and Darko *et al.,* (2018) in the determination of experts and reduction of CSF's will be adopted for participation in the AHP survey.

(INSERT TABLE II HERE)

From Table II, the mean cut-off of 4.0 will be adopted, hence, these factors yield an economic CSFs of 8, social CSFs of 6 and an environmental CSF of 4. Therefore, a pairwise comparison matrix of (8X8), (6X6 matrix) and (4X4) respectively were adopted in the AHP survey.

(INSERT TABLE III HERE)

The respondent's background information is contained in Table III. The educational status showed that 12.16% had National Diploma, 18.91% had Higher National Diploma, 36.49% had Bachelor of Science, 20.27% had Master of Science, 8.10% had Doctor of Philosophy while 4.05% had other certifications. This infers that the respondent's level of education enhanced the quality of data collected and their opinion can be relied upon. According to the respondents' year of professional practice, the highest proportion of respondents fall within the 6-10 years of practice. It could be concluded that the respondents have a moderate experience in the housing delivery industry thus making the information provided reliable. All the respondents had experience in sustainable housing. 13.52% have >2years', 22.97% have 2 to 4 years', 33.78% have 4 to 6 years' and 29.73% have more than 6years experiences in the practice of sustainable housing. Based on the result of the respondents' demographics, the opinions obtained served as representative for this study to guarantee the credibility of the findings.

Methods of Data Analysis

Mean score ranking analysis

The mean item score ranking analysis was used in the general survey to ascertain the relative criticality of the success factors to enter into the AHP survey. A 5-point measurement scale as said earlier was used.

Mean ranking analysis is a typical approach for ranking the relative significance of factors. This approach has been widely used in building and housing-related research (see Chan et al., 2018; Darko et al., 2017). In this study, the mean ranking analysis was adopted to ascertain the relative significance of the CSFs for sustainable housing delivery using a descending order of criticality built upon by the respondent's perception. For this research, where one or two variables have the same mean scores, their respective standard deviation scores were adopted in ranking the CSFs. The CSFs with the lowest SD takes the highest rank. A low standard deviation indicates that the responses differences are not large; hence the average is likely to be significant for the majority (Olawumi, 2019)

Mean ranking analysis was adopted in other to point out the CSFs that are critical to the study which should enter into the AHP survey. Since AHP survey performs better with small variable/factor, mean ranking analysis was used to reduce the large number of the CSFs to a sizeable number this was done to enhance a credible and effective AHP survey pairwise comparison (Cheng and Li, 2002). As presented in table II, CSFs with mean scores ≥ 4.0 were selected to enter into the AHP survey (Cheng and Li, 2002).

AHP survey analysis

The general survey conducted earlier for this study assisted in the selection of experts that can be used for the AHP survey. Since this study agreed to employ the benchmark set by Cheng and Li (2002) and Darko *et al*., (2018), professionals with more than 6 years' experience in sustainable housing provision were adopted for the AHP survey. These expert views were deemed credible since they can provide penetrating insights (Cheng & Li, 2002). Lam and Zhao (1998) argued that AHP survey is a peculiar method for studies related to the specific issue; hence the adoption of a large sample is not imperative. Travares *et al.,* (2008) argued that the peculiarity of AHP makes judgment from one expert to be deemed adequate. On the contrary, Cheng and Li (2002) suggested that the adoption of a large sample size for AHP study may lead to inconsistent judgment since many professionals may give arbitrary results. The peculiarity of AHP in housing studies and construction research could be tied to its capability to deal with small sample sizes. Studies (Zhang & Zou 2007; Lam et al., 2008; Dalal *et al.,* 2010; Li & Zou, 2011; Akadari *et al.,* 2013) have adopted respondents ranging from four to nine while Ali and Al-Nsairat (2009) employed a sample size of 30. Since the majority of the researches adopted a small sample size, it is imperative that to enable useful decision, consistent outputs and models, adoption of small sample size is preferable. Therefore 22 developers from the general survey with over 6 years' experience in sustainable housing were selected to participate in the AHP survey. The five-step AHP approach as put forward by (Tam *et al*., 2007) is herein adopted.

- **Problem definition:** This is the first step in the AHP survey. It defines the problems to be solved. In this study, the problem to be solved is how CSFs can be prioritized for sustainable housing delivery.
- **Hierarchy formation:** The three-stage hierarchy of the CSFs for sustainable housing delivery was adopted for this study. The major goal and the sub-criteria are contained in the first and the second level respectively. The third stage contains the CSFs under each category. Based on the pilot survey conducted and presented in Table II, a proposed hierarchical model to priorities the CSFs are presented in Figure 1. The identified CSFs are in three categories and the structure of the hierarchy of their respective sub-factors is provided.

(INSERT FIGURE 1 HERE)

- **Pairwise comparison:** Having formed the hierarchy, the elements at the respective hierarchy level formed the matrixes. The study adopted the 8x8; 6x6 and 4x4 matrixes. In this study, the weighing of the CSFs was carried out to examine the strength of the CSF against the other using the AHP pairwise scale. The pairwise comparison was derived using:

$$A=\begin{bmatrix} a_{11} & a_{12} & .. & a_{1j} & .. & a_{1m} \\ a_{21} & a_{22} & .. & a_{2j} & .. & a_{2m} \\ . & . & .. & . & .. & . \\ . & . & .. & . & .. & . \\ a_{i1} & a_{i2} & .. & a_{ij} & .. & a_{im} \\ . & . & .. & . & .. & . \\ . & . & .. & . & .. & . \\ a_{m1} & a_{m2} & .. & a_{mj} & .. & a_{mm} \end{bmatrix} = (a_{ij})\ m \times m$$

Where A = pairwise matrix, *aij* = the relative significance of factor *"i"* when compared with factor *"j"*, m = number of variables in the matrix.

(INSERT TABLE IV HERE)

- **Consistency Test:** This was conducted to ascertain the judgment consistency. This test ensures that only consistent matrixes are included in further analysis. The formula used in calculating the highest eigenvalue and vector is:

$$\lambda_{max} = \sum_{j=1}^{m} \frac{Aw}{Mw1} (i = 1,2,...,m)$$

Where λ_{max} represents matrix the highest eigenvalue, A denotes the pairwise matrix; *w* stands for the matrix of weights of elements, and $w_i$stands for the element's weights.

The consistent level of the judgment was determined using the Consistency Ratio (CR) which was computed by the formula:

$$CR = \frac{CI}{RI} = \frac{1}{RI}\left(\frac{\lambda_{max} - m}{m-1}\right)$$

Where CI refers to the consistency index; CR is the consistency ratio; RI denotes the random index and *m* means the number of CSFs in the matrix.

- **Weight Calculation:** The weights of the CSFs were arrived at by estimating the eigenvector matrix and the consistency measure of the judgment as obtained by calculating the maximum eigenvalue. The AHP survey calculated the weight of the CSFs at each hierarchy level to establish priorities among the elements. This was obtained by:

$$n_i = \prod_{j=1}^{m} aij (i = 1,2,...,m)$$

Where *ni* represents the multiplication of the relative importance for each row of CSFs; a_{ij} represents the relative importance of the CSFs *"i"* were compared with CSFs *"j"* and *m* represents the number of CSFs in the matrix.

Vector $\overline{w_i}$ was calculated by:

$$\overline{w_i} = \sqrt[m]{n_i (i = (1,2,...,m)}$$

Where w_i represents the m[th] power of n_i

$$w_i = \frac{\overline{w_i}}{\sum_{i=1}^{m} w_i} (i = 1,2,...,m)$$

The weights of the CSFs were calculated by normalization of the vector: where $w_i$stands for weights of CSFs and criteria.

4.0 Results

Testing Comparability of the CSFs for achieving sustainable housing delivery using AHP survey

Based on the results in Table II, a three-level initial hierarchical model for identifying CSFs to achieve sustainable housing delivery is proposed as illustrated in Figure 1. This proposed model comprises only the CSFs that were found to be crucial in this study which entered the AHP survey. The top level of the model is occupied by the prioritization goal. The second level is occupied by three main pillars of sustainability. The third level constitutes the CSFs derivable from the CSF categories in level two. In this level, the various CSFs in each CSF category are given in descending order of importance, according to the result in Table II. This proposed model enhanced the AHP survey analysis and was later modified to develop the final model of the CSFs in delivery sustainable housing in this study using the result of the AHP survey analysis. Therefore, a total of 22 questionnaires were administered on the experts for the AHP survey and due to the peculiarities of the method, responses with CR≤ 0.1 were retained as suggested by (Saaty, 1980) Therefore, only 12 responses were found to be good and fit for the study as their CR≤0.1. Table V showed the result of the AHP survey.

(INSERT TABLE V HERE)

Table V showed the result of the AHP survey of the 18 CSFs. The table presents the Consistency Ratio (CR), Consistency Index (CI), and the average weights of all the CSFs. Out of 22 experts, only 12 were consistent in their decision in all the three categories of the CSFs with their (CR) ≥ 0. Finding from the AHP survey revealed that the weights of the Economic CSFs ranged from 0.056 to 0.231, establishing priorities among the CSFs. On the economic category of success factors, government funding towards sustainable housing (CSF01) ranked first with a weight of 0.231, access to low-interest housing loan (CSF02) ranked 2[nd] weighting 0.152 while mandating affordable housing development (CSF05) ranked 3[rd] with a weight of 0.122.

The weights of the social CSFs range between from 0.078 and 0.277. Based on the social category of the success factors, ensuring community participation during housing delivery (CSF 13) ranked 1[st] with a weight of 0.277, the involvement of housing stakeholders (CSF 16) ranked 2[nd] with a weight of 0.221 and ensuring security of life and properties (CSF 14) ranked 3[rd] with a weight of 0.153. The result also revealed the environmental category of success factor with weights ranged from 0.128 to 0.466. The use of sustainable materials (CSF 22) ranked 1[st] with a weight of 0.466, adaptable housing design (CSF 24) ranked 2[nd] with a weight of 0.256 and befitting land use plan (CSF 23) ranked 3[rd] with a weight of 0.136.

(INSERT FIGURE 2 HERE)

Discussions and implications

To attain sustainability in housing delivery economically, there should be appropriate funding for sustainable housing delivery. In the same vein, the financial institution should make a provision of affordable lending rate for a housing loan and such should be easily accessible to the developers. This finding supports that of Oyebanji, *et al.,*(2017) where it was established that adequate funding and government provision for housing is crucial for the successful delivery of sustainable housing. The findings of this current study also corroborate Adabre and Chan (2019) that in other to achieve sustainable but affordable housing delivery, housing loan should be made accessible to the clients, developers and other construction professionals at a very low-interest rate. The finding of Oyebanji et al., (2017) was confirmed by this current study that affordability in housing is the most vital success factors for attaining a sustainable housing delivery. However, this study did not support the findings of Nurul and Khadijah, (2017) where it was stated that a stable economic system is imperative for the sustainability of housing delivery.

Under the social pillar, the study found out that the CSFs that needed in achieving sustainable housing delivery include ensuring effective and efficient community participation and development, the involvement of housing stakeholders and ensuring the security of life and properties. These findings tally with that of Oyebanji *et al.,(*2017) where it was recognized that community and stakeholders' participation in the decision-making process on housing delivery and access to social services are crucial to attaining social sustainability. In the same way, the findings of this study agree with that of Hassan *et al.,* (2010) that top management support and participation is very crucial in achieving social sustainability in housing delivery. Adinyira *et al.,(*2012) findings were also in tandem with this current study that safety and security of the citizen are critical to social sustainability.

The AHP study also found out that there exist 3 major CSFs under the environmental pillars that can be embedded in housing delivery to ensure sustainability. The study revealed that the use of sustainable materials, adaptable housing design and befitting land use plan for housing through avoidance of misuse and excessive land, human and financial resources use are the CSFs that could be lead to environmental sustainability. The finding in this study is like that of Adabre & Chan,(2019) where it was revealed that appropriate and mixed land use plan is very critical in achieving environmentally-friendly housing. This is also the submission of Adinyira, *et al.,* (2012) and Hamid *et al.,* (2018) that sustainable and environmentally friendly materials are very important in sustainable housing delivery as it would reduce maintenance and life-costs of such housing.

Practical Implications

Developers, practitioners and policymakers faced with the challenges of identifying and choosing the appropriate combination of the CSFs to promote sustainable housing delivery may pay attention and act on the CSFs with higher priorities among other CSFs categories. The appropriate application of the CSFs would promote sustainability attainment in housing through improving the quality of lives of people, creation of sustainable cities and communities thus setting the standard for other cities and future development, creation of jobs, protection of the environment, meeting housing needs of those living and preserving that of the unborn (Moore *et al.*, 2017). The developed model might help practitioners when delivering sustainable housing within limited means, as it can be relied on in selecting the apt

combinations of CSFs which will eventually promote sustainability of project success. The priorities established amongst the CSFs might help practitioners when delivery sustainable housing within limited resources, and when it is not possible or necessary to implement all the CSFs in a single project. In such a situation, the priorities can be relied upon to identify and select the most appropriate combination of CSFs to eventually achieve a sustainable project. Government participation and efforts in housing delivery through reduction of housing loan are very critical in promoting sustainable housing. This means that government reduction of housing loan interest with proper budgeting and funding for housing would promote housing affordability (Adabre & Chan, 2019).

Moreover, the participation of the community during housing would have a positive impact on sustainability thus enhancing the housing social goals. The participation of various stakeholders in the built environment in ensuring the highest and best use of land through appropriate land use planning would greatly influence sustainable housing delivery and would set a standard for future design and construction of housing. This was what Li, *et al.,* (2013) submitted that going sustainable would set and standard for future and improve countries performance. In the same way, the adoption of sustainable material may have an impact on the selection of locally made sustainable housing materials which are affordable and accessible. This would promote the market for locally made sustainable materials. Moreover, a further implication of this study is that developers would have a clear vision of the appropriate mix of CSF which would promote sustainable development goals of a nation.

Conclusion and recommendations

AHP survey has been used in this study to evaluate the CSFs for achieving sustainability in Lagos housing market. AHP is adopted for pairwise comparison of the decomposed CSF's to assign weights to it. The study established that promoting sustainable housing requires government funding towards sustainable housing, access to low-interest housing loan, mandating affordable housing development, ensuring community participation during housing delivery, the involvement of housing stakeholders, ensuring the security of life and properties, use of sustainable materials, adaptable housing design and befitting land use. The identified CSF's are crucial to promoting government sustainability programs and meeting housing needs. Hence, the findings of this study if well implemented and adopted will enhance a livable neighbourhood. It is recommended that developer and other construction professionals should not overlook the CSF's that can enhance sustainable housing delivery and minimize cost and wastage. A further recommendation is that developers and other construction professionals should remain focused on the Sustainable Development Goals tied to housing as this is the argument for sustainable housing delivery, which is hanging on the appropriate application of the selected CSFs. The decision of the stakeholders should be more proactive through proper collaborative efforts and must pay attention to CSFs required for a sustainable housing provision. To provide more evidence on the CSFs, further research should be carried out in other states to compare findings and to provide a better foundation for the CSFs for sustainable housing delivery in Nigeria.

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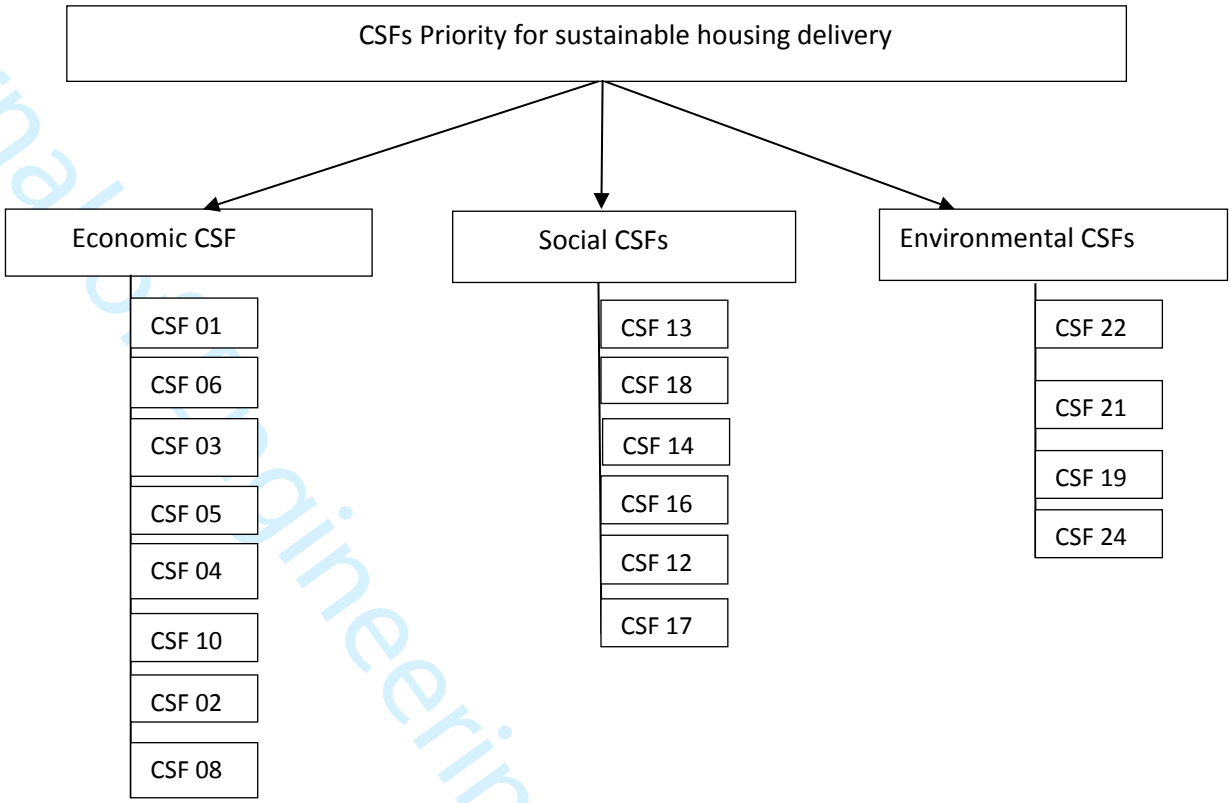

Note: The codes of the CSF corresponds to the codes in Table I

Figure 1: The initial conceptual model of the CSFs in delivering sustainable housing based on pilot survey

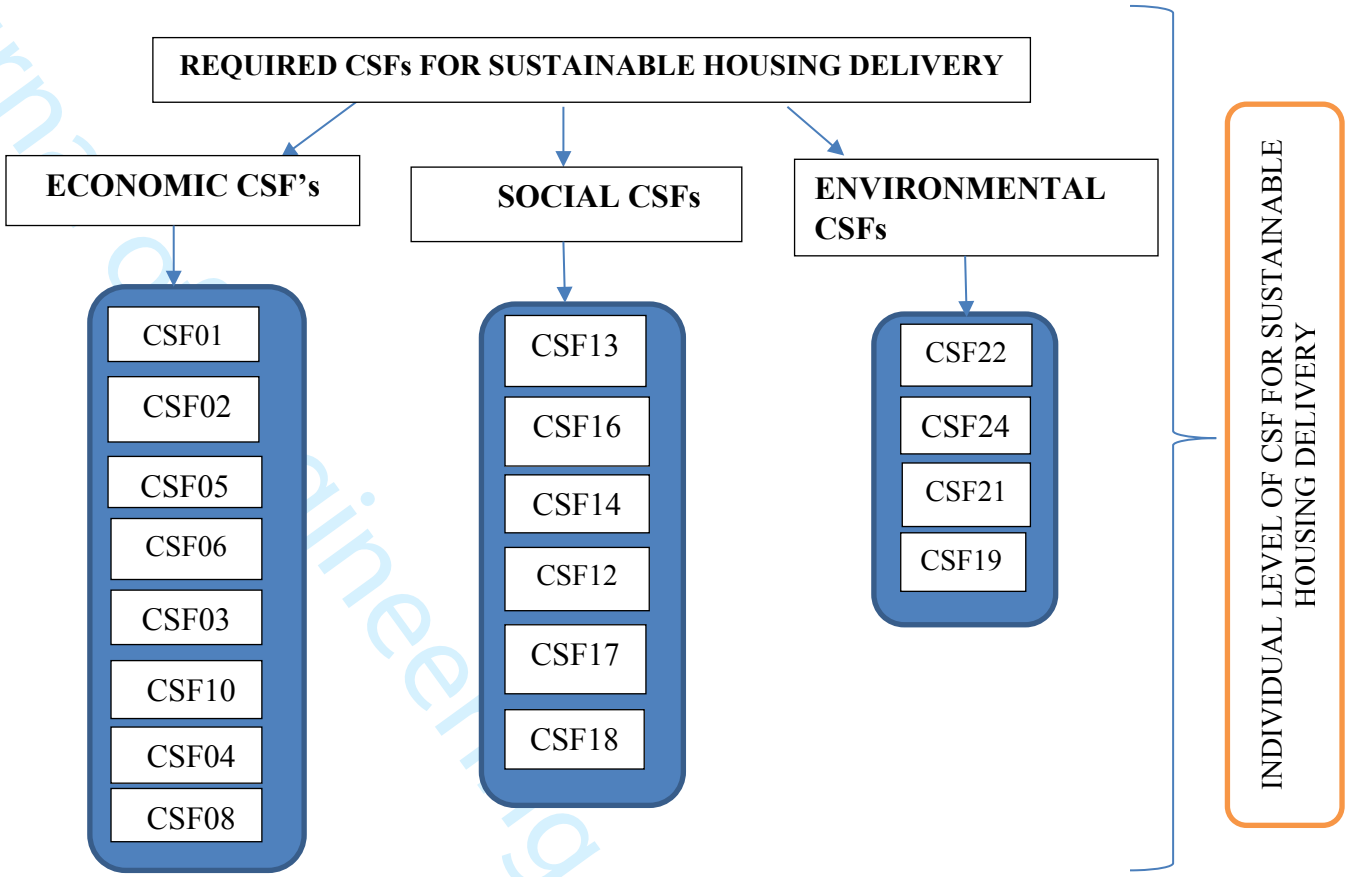

Figure 2: Final Model of the CSFs for sustainable housing delivery based on the weights

Table I : Literature search for CSF's Critical to Sustainable Housing Delivery

Codes	Critical Success Factors		Authors
	Category	Sub factors	
CSF01	Economic	Funding towards sustainable housing	Oyebanji et al., (2017), Adabre & Chan (2019)
CSF07		Supply of Infrastructural facilities	
CSF09		Subsidy on housing for households	
CSF02		Access to low interest housing loan	Adinyira et al., (2012), Nurul & Khadijah (2017), Hamid *et al*., (2018), Adabre & Chan (2019)
CSF03		Sound economic system	Nurul & Khadijah (2017)
CSF05		Compulsory affordable housing development	Oyebanji et al., (2017)
CSF08		Availability of government developed land at low cost	Hassan et al., (2010)
CSF04		Incentive for the inclusion of affordable housing units	Adabre & Chan (2019)
CSF06		Political dedication to housing affordability	
CSF10		Provision of guarantee by government to developers	
CSF11	Social	Promoting public sensitization on sustainability	Adabre & Chan, (2019)
CSF12		Provision of quality and standard housing	
CSF13		Ensuring community participation during delivery	
CSF14		Ensuring security of life and properties	
CSF15		Promotion of impartiality during allocation	
CSF16		Involvement of housing stakeholders	Hassan et al., (2010), Youneszadeh *et al.,* (2017), Hamid *et al.,* (2018)
CSF17		Good collaboration among developers	Chan et al., (2004)
CSF18		Promoting social housing policies	Hamid *et al*., (2018)
CSF19	Environmental	Promoting environmental assessment and protection	Oyebanji *et al.,* (2017)
CSF20		Adequate accessibility and proper location	
CSF21		Befitting land use plan	Adabre & Chan (2019)
CSF22		Use of sustainable materials	Adinyira *et al.,* (2012), Hamid *et al,* (2018)
CSF23		Submission to quality target	Oyebanji *et al.,* (2017), Adabre & Chan (2019)
CSF24		Adaptable housing design	

Source: Author's compilation, 2020

Table II: Pilot survey opinion on CSF for achieving sustainable housing delivery

CSF categories	Codes	Lists of Critical Success Factors	Mean	SD
Economic	CSF01	Government funding towards sustainable housing	4.72	.609
	CSF06	Political will and commitment to affordable housing	4.69	.636
	CSF03	Sound macro-economic system	4.68	.526
	CSF05	Mandating affordable housing development	4.64	.674
	CSF04	Incentive for developer to include affordable housing units	4.61	.808
	CSF10	Provision of guarantee by government to developers	4.27	.880
	CSF02	Access to low interest housing loan	4.31	.810
	CSF08	Availability of government developed land at low cost	4.11	1.256
	CSF09	Subsidy on housing for households	3.15	1.331
	CSF07	Supply of Infrastructural facilities	3.04	1.565
Social	CSF13	Ensuring community participation during delivery	4.61	.593
	CSF18	Promoting social housing policies	4.45	.577
	CSF14	Ensuring security of life and properties	4.34	.781
	CSF16	Involvement of housing stakeholders	4.32	.704
	CSF12	Provision of quality and standard housing	4.28	.868
	CSF17	Good collaboration among developers	4.16	.777
	CSF11	Promoting public sensitization on sustainability	3.23	1.429
	CSF15	Promotion of impartiality during allocation	3.41	1.552
Environmental	CSF22	Use of sustainable materials	4.42	.597
	CSF21	Befitting land use plan	4.23	.803
	CSF19	Promotion environmental assessment and protection	4.19	.771
	CSF24	Adaptable housing design	4.15	.696
	CSF23	Submission to quality target	3.86	1.297
	CSF20	Ensuring good accessibility and location	3.42	1.182

Table III: Respondents demographics

Category	Characteristics	Frequency	Percentage
Educational status	ND	9	12.16
	HND	14	18.91
	B.Sc/B.Tech	27	36.49
	M.Sc/M.Tech	15	20.27
	Ph.D	6	8.10
	Other qualifications	3	4.05
	Total	***74***	***100.0***
Years of professional practice	1 - 5 years	27	36.49
	6-10years	31	41.89
	11-15 years	9	12.16
	More than 20 years	7	9.45
	Total	***74***	***100.00***
Years of experience in sustainable housing provision	> 2 Years	10	13.52
	2- 4 Years	17	22.97
	4-6years	25	33.78
	Above 6 years	22	29.73
	Total	***74***	***100.00***

Table IV: Linguistic Measurement Scale for Relative Importance Using AHP pairwise Comparison

Preference intensity	Reciprocal	Linguistic variables
1	1	Equal importance
3	1/3	Moderate importance
5	1/5	Essential or strong importance
7	1/7	Very strong importance
9	1/9	Absolute importance
2,4,6,8	1/2,1/4,1/6,1/8	Intermediate value between the two adjacent judgements. It is the value when compromise is needed.

Each expert expresses his/her judgement using the linguistic scale in Table IV.

Table V: AHP Survey Matrix of the CSFs (as determined by the experts)

Classes of CSF's	Codes	Respondents/Experts judgment												Average weight	Rank
		1	2	3	4	5	6	7	8	9	10	11	12		
ECONOMIC (8x8 Matrix)	**CSF01**	0.291	0.276	0.308	0.232	0.195	0.278	0.104	0.197	0.323	0.232	0.248	0.092	**0.231**	1st
	CSF02	0.044	0.133	0.072	0.255	0.151	0.075	0.154	0.190	0.133	0.291	0.077	0.253	**0.152**	2nd
	CSF03	0.006	0.257	0.248	0.052	0.086	0.042	0.097	0.057	0.121	0.179	0.112	0.080	**0.111**	5th
	CSF04	0.125	0.153	0.036	0.143	0.092	0.071	0.046	0.056	0.153	0.067	0.178	0.004	**0.094**	7th
	CSF05	0.131	0.044	0.072	0.171	0.164	0.084	0.313	0.205	0.038	0.058	0.081	0.097	**0.122**	3rd
	CSF06	0.131	0.084	0.149	0.076	0.074	0.235	0.036	0.047	0.146	0.047	0.106	0.310	**0.120**	4th
	CSF08	0.009	0.023	0.083	0.031	0.089	0.032	0.096	0.056	0.133	0.047	0.029	0.042	**0.056**	8th
	CSF10	0.131	0.042	0.036	0.048	0.149	0.168	0.154	0.190	0.047	0.079	0.168	0.090	**0.109**	6th
	C.I	**0.004**	**0.012**	**0.098**	**0.069**	**0.140**	**0.096**	**0.081**	**0.123**	**0.053**	**0.138**	**0.134**	**0.006**		
	C.R	**0.003**	**0.009**	**0.069**	**0.049**	**0.099**	**0.068**	**0.058**	**0.087**	**0.037**	**0.098**	**0.095**	**0.043**		
SOCIAL (6x6 Matrix)	**CSF12**	0.039	0.046	0.062	0.031	0.283	0.005	0.078	0.003	0.187	0.177	0.242	0.233	**0.096**	4th
	CSF13	0.291	0.406	0.465	0.159	0.195	0.499	0.421	0.543	0.027	0.051	0.270	0.183	**0.277**	1st
	CSF14	0.171	0.145	0.073	0.341	0.283	0.230	0.008	0.054	0.187	0.061	0.278	0.090	**0.153**	3rd
	CSF16	0.380	0.265	0.054	0.345	0.084	0.100	0.235	0.148	0.474	0.486	0.081	0.407	**0.221**	2nd
	CSF17	0.079	0.009	0.318	0.079	0.069	0.022	0.030	0.075	0.062	0.048	0.098	0.054	**0.079**	5th
	CSF18	0.039	0.044	0.028	0.045	0.097	0.100	0.157	0.148	0.062	0.177	0.033	0.033	**0.078**	6th
	C.I	**0.100**	**0.086**	**0.085**	**0.115**	**0.031**	**0.102**	**0.011**	**0.031**	**0.028**	**0.028**	**0.103**	**0.128**		
	C.R	**0.081**	**0.067**	**0.068**	**0.093**	**0.025**	**0.083**	**0.009**	**0.025**	**0.023**	**0.023**	**0.083**	**0.100**		
ENVIRONMENTAL (4x4 Matrix)	**CSF19**	0.472	0.107	0.370	0.066	0.083	0.058	0.034	0.138	0.045	0.058	0.039	0.063	**0.128**	4th
	CSF21	0.087	0.058	0.074	0.128	0.248	0.145	0.229	0.076	0.154	0.143	0.176	0.114	**0.136**	3rd
	CSF22	0.199	0.221	0.309	0.608	0.619	0.662	0.574	0.108	0.428	0.626	0.609	0.633	**0.466**	1st
	CSF24	0.241	0.414	0.247	0.198	0.201	0.135	0.141	0.579	0.373	0.173	0.176	0.190	**0.256**	2nd
	C.I	**0.089**	**0.084**	**0.087**	**0.000**	**0.020**	**0.031**	**0.010**	**0.028**	**0.088**	**0.031**	**0.081**	**0.008**		
	CR	**0.098**	**0.093**	**0.097**	**0.000**	**0.022**	**0.034**	**0.012**	**0.031**	**0.098**	**0.034**	**0.099**	**0.009**		

C.R = consistency ratio, C.S.F = critical success factors, C.I = consistency index