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Application of sustainable development principles in housing projects in Anambra State, Nigeria

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ABSTRACT

The wider choice of housing design, use, and application is one of the more obvious influences of modernity as sustainable housing projects of various sizes and shapes are now seen in contemporary societies. However, it seems that the concept of sustainable housing is not properly incorporated in Nigeria from which Anambra State is not exempted. Therefore, the study appraises the extent of incorporating sustainable development (SD) principles in housing projects in Anambra State, Nigeria. The study adopted a survey research technique involving a questionnaire, using the construction project sustainability analysis system (CPSAS) to evaluate the level of SD incorporation in housing projects. A total of 78 respondents administered questionnaires for data collection. However, 62 questionnaires were validated for analysis. Data collected were analysed using the mean score, simple percentages, and RII and finally, the overall project sustainability index (PSI) was analysed using CPSAS. The study revealed that the level of incorporation of SD principles in housing projects is still below average, which the PSI has shown to be 40%. Based on this, it is recommended that there should be more education and awareness by all stakeholders on the importance of sustainable housing projects. Socio-cultural, economic, and environmental degradation must be tackled in a more integrated and holistic way, hence, the government of Anambra State should formulate and implement social, financial, and environmental policies for housing project delivery.

Keywords: housing, sustainable development, construction project, Anambra, Nigeria

INTRODUCTION

The complexity of modern technology has led to an increasing design of sophisticated housing with very complex yet unique designs which have reshaped the traditional way of building (Ezeokoli et al., 2023). Conventional designs have seen several changes due to the influence of modernity, geographical and climatic conditions as well as affluence. The wider choice of housing design, use, and application is one of the more obvious influences of modernity as longer-lasting housing projects are now seen in contemporary society. Okwu et al. (2017) stated that housing is one of the three basic needs of mankind following closely after food, which is the most important factor for the physical survival of mankind. Ezennia and Hoskara (2019) agree that poor housing and housing dissatisfaction have prolonged and adverse effects on the health, environment, and social and political unrest of the residents and the nation. This is why Habitat for Humanity (2015) defines housing as the process of providing safe, comfortable, functional, and affordable shelter in a proper setting within the neighbourhood, supported by the continuous maintenance of the built environment for the living activities of individuals or families within the community which commensurate reflection of the socio-economic and cultural aspiration and preferences. Housing is an integral part of human development. According to DuPisani (2006), development is an evolutionary process in which human capacity increases by initiating and creating new structures, solving problems, adopting continuous change, and deliberately and creatively striving to attain new goals.

The concept of sustainable development (SD), according to Mensah and Casadevall (2019) and Ezeokoli et al. (2023), has been widely debated in theoretical importance in areas of social, policy, and academic circles over the years. Although the concept has gained prominence and is famous in theory it tends to be neglected in practice (Ezeokoli et al., 2023; Mensah & Casadevall, 2019). The report of the World Commission on Environment and Development (WCED, 1987) defined SD as the development that meets the needs of the present without

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undermining the ability of future generations to meet their own needs. SD is an important concept in today's world and is accepted as the basis for measuring global development (Kioumarsi et al., 2022). The key goal of SD is to achieve environmental equilibrium, economic growth, and social progress (Gossling-Goidsmith, 2018; Zhai & Chang, 2019).

In developing countries, Ebekozien et al. (2024) and Ezeokoli et al. (2023) opined that the construction industry through its project execution plays an active role in the improvement and attainment of sustainable development goals. Therefore, sustainable housing is defined as providing housing that integrates environmental, and societal best practices intending to reduce the negative impacts of homes on the environment through eco-friendly design, sustainable building materials, and construction practices (Gilkinson & Sexton, 2007). Based on this, Kumar (2024) and Du Plessis (2002) opined that the intent of sustainable construction (SC) is to build societies where respect for economic justice, and human dignity are religiously pursued and a balance between the built and natural environments are maintained. No wonder Hak et al. (2016) stated clearly that due to the increase in population, there is a need for more consciousness of the SD phenomenon; global concerns have always been expressed for the judicious use of available resources. So it will always be possible to satisfy the needs of the present generation without undermining future generations on their own needs. This is achievable through the integration and incorporation of environmental, economic, and social concerns in the decision-making processes by policymakers, developers, project managers, and other stakeholders in housing projects (Kolk, 2016). Simply, sustainability is all about environmental protection, social impact, and economic fairness (Moshood et al., 2024).

In Anambra State, the extent to which SD principles are integrated into the design and construction of buildings is still questionable. Most buildings are developed with little or no regard for SD principles. Most of the existing studies in this regard in the state focus mainly on SD appreciation and its applications in other areas and sectors of the economy. The existing studies on this across the board in the study area are Okafor et al. (2021), Egwu and Mbonu (2023), and Ngwaka and Obiekwe (2021) worked in the education sector while Uzor and Ikenga (2024) worked in the security sector; other such as Okoye and Nnaji (2023) worked on cooperative society; Chukwudi and Owoh (2023) looked at community development; U-Dominic et al. (2023) consider the application of SD concept in commercial buildings, Nwagbala et al. (2024) looked at SD and capacities buildings of Nigerian Population Commission. Other existing works like Ezeokoli et al. (2023) and Okoye and Ngwu (2021) looked at the other aspects of SD in the housing sector and not its application in the housing sector. Also, none of the existing work on this concern utilizes construction project sustainability analysis system (CPSAS) techniques propounded by Yu et al. (2018) in evaluating the extent of the application of SD principles in building projects. On this note, this study assesses the extent of the application of SD principles in the design and construction of housing projects in the study area using construction project sustainability assessing system (CPSAS) techniques.

LITERATURE REVIEW

Measurement of Sustainable Development and Sustainability in Building Projects

Evaluating the compliance of building projects to sustainability requires methodologies that measure the environmental, social and economic aspects of sustainability through set criteria (Kumar et al., 2023). Hence, according to Odebiyi (2010), sustainable building is measured in terms of its resource utilization and management for example: water, energy, waste/recycling, and the practice of the design and construction of buildings. Also, it can be assessed by its environmental, social economic, and perhaps cultural values measurable by the impact and trade-offs. In terms of building sustainability, the indices of measurement involved environmental, social, and economic indicators. Other indicators include benchmarks, audits, sustainability standards, and certification systems like Fairtrade and organic, indexes, accounting, assessment, and appraisal (Dalal et al., 2009). This has a wide range of applications both in terms of spatial and temporal scale (Hak et al., 2007).

According to Brandli et al. (2006), sustainability is evaluated by identifying the life-cycle cost of the building. This involves assessing the location features, its convertibility, flexibility, internal living circumstances, and environmental dimensions during the construction, and operation. Also, safety features, comfort and the impact of the building in the area must be considered. However, in doing this, issues bordering on the dynamics of SD and reducing them to measurable items must be clearly interpreted, apprehended, presented and easily communicated to the policymakers. This has often been remains a daunting task (United Nations, 2009). In measuring the sustainability of building projects, there are need to carefully review every domain of the sustainability for the project. Also, there is a need to provide an adequate framework that informs policymakers about major trends and issues which must support in-depth analysis. This technique must emphasise the importance of sustainability and must help the building owners and designers meet higher standards when it comes to building design and on-site construction (Kumar, 2024). Also, this is required at the early stages of design when choices made in this area have a significant influence on the built environment's overall performance (Kumar et al., 2023).

In furtherance, Hecht (2006) opined air quality is one of the three major criteria for establishing whether a building project/system is sustainable. Because it addresses environmental health, which is a partial measure of sustainability. Based on this, Chiu (2004) opined that the assessment tools used to measure the sustainability of any construction work must consider environmental and economic impacts. It is admissible to argue that most of these tools are not comprehensive enough to assess the sustainability of construction buildings without being able to measure the social impacts of the construction (Mohammad & Amato, 2006). In addition, Mohammad and Amato (2006) maintained that the measurement of SD in housing cannot be deliberated without understanding the indicators. Indicators are measures to evaluate progress toward goals and objectives. Its uses

Table 1. Field or dimensional framework category of sustainability

Economic framework	Social framework	Environmental framework	Institutional framework
Productivity Growth Development Consumption Infrastructure, equipment, and transportation Housing	Demographics Education Health Combating poverty Urban and regional development Equality	Global climate change Air pollution Soil pollution Water pollution Other types of pollution Biodiversity The integrity of ecosystems Energy consumption Water consumption Raw materials consumption Other intermediate goods Environmental quality Urban reforestation and green spaces	Policies and decision-making Environmental management National legal instruments International legal instruments Information and statistics Science and investigation for sustainable development

include helping identify trends, predict problems, assessing options, set performance targets, and considering a particular jurisdiction or organisation. Indicators are equivalent to senses (sight, hearing, touch, smell, and taste) they can help determine how problems are defined and which impacts receive attention (Hecht, 2006). To track green growth and SD, nations require action plans and metrics that are well-defined. Adopted policies and laws by nations must adhere to established international norms and understand SD within the framework of the green economy (Kumar, 2024).

Sustainability Indicators

A sustainability indicator is a tool that captures and examines certain areas of SD in such a way that is easy to comprehend and communicate, permitting monitoring, evaluation, and subsequently the execution and conduction of a public policy or process of management (Ryding et al., 2003). The amount of sustainability indicators rests on the extent of scrutiny needed to be done as well as the variables and categories that define each case. In summary, the sustainability indicators are many and cover each field/principle of SD (i.e., social, environmental, and economic). Also, it involves other fields or areas such as cultural, political, and institutional (Hernandez-Moreno & De Hoyos-Martinez, 2010). These other fields/principles are not directly related to SD according to the basic definition (United Nations, 1982) but are incorporated since political aspects are directly part of management and culture is a question of education. Furthermore, integrating these principles should address other aspects such as green energy, circular neighbourhoods, and climate-driven strategies and must attempt to take sustainability measures within their operation standards to achieve environmentally conscious goals, cutting costs and encouraging creativity (Usanova et al., 2024).

Sustainability principles in a building project according to Moshood et al. (2024), must consider the following: provide consumers with an eco-friendly, balanced, safe, and usefully constructed ecosystem; protect the world for the next generation while simultaneously addressing today's needs; assess the well-being of the project and its economic effect on culture and the environment; reduce the damage to the ecosystem; improving the consistency of services and utilities and exercising collective harmony; increase the project's feasibility and effectiveness with the assistance of technologies and professional expertise; and setting up policies and understanding. In furtherance, the guiding principles for SC projects and product systems according to Moshood et al. (2024) include minimizing the use of natural resources, manufactured inventory, and packaging; minimizing the use of single-use items that cannot be recycled or composted; switching from the use of materials derived from fossil fuels to materials and products derived from renewable feedstocks; and taking sustainability into account at every stage of a material's life cycle.

According to Hernandez-Moreno and De Hoyos-Martinez (2010), sustainable indicators can be local, regional, or global, depending on the case and the objectives of the study. At a local and state level, authorities are interested in the decision-making process for urban development; at a regional or federal level, institutions and various service agencies are interested in knowing these indicators to have comparable information for the management of diverse projects and programmes; while at an international or global level, the knowledge of these indicators can be useful for financing a regional development project with international resources (Hernandez-Moreno & De Hoyos-Martinez, 2010). Hernandez-Moreno and De Hoyos-Martinez (2010) categorized urban sustainability into four categories according to the dimensional framework from the field of SD which are demonstrated in **Table 1**.

Yu et al. (2018) observed that previous research has proposed many industrial or national sustainability evaluation indicator systems. However, no project-level sustainability evaluation system for the evaluation execution and monitoring of the sustainability status of construction projects has been developed. Also, Yu et al. (2018) further argue that without such an evaluation system, it will be almost impossible to plan, select, and operate sustainable building projects. To meet the abovementioned requirements, Yu et al. (2018) present an effort conducted in Taiwan to propose a CPSAS considering three pillars of sustainability: environmental, social, and economic, based on theoretical backgrounds from existing literature and former successful sustainable projects. It was concluded that the proposed CPSAS is useful for construction stakeholders to achieve sustainability more effectively during the execution of construction projects by adhering to the defined sustainability criteria for each indicator. The validity and reliability test for this model was done using three green building projects and two civil infrastructure construction projects in Taiwan. It was concluded that the proposed CPSAS is useful for construction

Table 2. CPSAS

SP	SC	Sub-SC	SI	Definition of indicators	Abbreviation	Unit	Project phase
E	E1	E1a	E1a1	Project development area ratio	DAR	%	
		E1b	E1b1	The ratio of borrowed soil	RBS	%	
			E1b2	The ratio of concrete usage	RCU	%	
		E1c	E1c1	Measure of water savings	MWS	No	
			E1c2	The measure of water recycle	MWR	No	
		E1d	E1d1	The measure of energy savings	MES	No	
			E1d2	Usage of green energy	UGE	Y/N	
	E2	E2a	E2a1	The measure of air pollution prevention	APP	No	
			E2a2	Usage of low air pollution method	LAP	No	
		E2b	E2b1	The measure of water pollution reduction	WPR	No	
		E2c	E2c1	The measure of solid waste reduction	SWR	No	
		E2d	E2d1	The measure of noise reduction	MNR	No	
		E2e	E2e1	Alternative for toxicant	AFT	No	
			E2e2	Sage of green labeled product	GLP	%	
		E2f	E2f1	Low GHG emission method	LGM	No	
	E3	E3a	E3a1	The ratio of planting area	RPA	%	
			E3a2	Establishment of habitation	EOH	Y/N	
		E3b	E3b1	Avoid bio-sensitive area	ABA	Y/N	
			E3b2	Avoid disaster sensitive area	ADA	Y/N	
		E3c	E3c1	Usage of vertical green planting	VGP	Y/N	
S	S1	S1a	S1a1	Improvement of average occupation area	AOA	Y/N	
			S1a2	Improvement of infrastructure	IOI	Y/N	
			S1a3	Certified green building	CGB	No	
		S1b	S1b1	Prevention of disaster	POD	Y/N	
			S1b2	Protection of stakeholder's safety	PSS	Y/N	
	S2	S2a	S2a1	Measure of conserving cultural monument	CCM	Y/N	
	S3	S3a	S3a1	Free access for the disabled	FAD	No	
	S4	S4a	S4a1	Participation of local residents	PLR	Y/N	
			S4a2	Fair sharing of benefit	FSB	Y/N	
EC	EC1	EC1a	EC1a1	The ratio of local employment	RLE	%	
			EC1a2	Self-liquidation ratio	SLR	%	
				MWS-Measure of water savings	-	Fail	
				MWR-Measure of water recycle	-	Fail	
				MES-Measure of energy savings	-	Fail	
				UGE-Usage of green energy	-	Fail	
				RPA-Ratio of planting area	-	Fail	
				POD-Prevention of disaster	Pass	-	
				PSS-Protection of stakeholders' safety	-	Fail	
				MCC-Measure of conserving cultural monument	Pass	-	
				FAD-Free access for the disable	-	Fail	
				PLR-Participation of local residents	Pass	-	
				FSB-Fair sharing benefit	-	Fail	
				RLE-Ratio of local employment	Pass	-	
				Total	**6**	**9**	

stakeholders to achieve sustainability more effectively during the execution of a construction project (Yu et al., 2018).

Table 2 shows the CPSAS.

Table 3 shows the applicability of sustainability indicators in the project life cycle. **Table 4** shows the CPSAS with criterion.

Table 3. Applicability of sustainability indicators in the project life cycle (Yu et al., 2018)

SP	SC	Sub-SC	SI	Abbreviation	Unit	Project phases							
						I	P&D	C	M&C	TO	O	M	D
E	E1	E1a	E1a1	DAR	%	VI	VI	M	MI	MI	MI	-	-
		E1b	E1b1	RBS	%	MI	VI	I	MI	-	-	-	-
			E1b2	RCU	%	-	VI	VI	I	-	-	MI	-
		E1c	E1c1	MWS	No	M	VI	VI	M	MI	I	M	-
			E1c2	MWR	No	M	VI	VI	M	MI	I	I	-
		E1d	E1d1	MES	No	MI	VI	VI	M	MI	I	M	-
			E1d2	UGE	Y/N	M	I	M	MI	MI	M	MI	-
		E2a	E2a1	APP	No	MI	M	VI	M	MI	M	M	MI
			E2a2	LAP	No	MI	I	VI	M	MI	-		

Table 3 (Continued). Applicability of sustainability indicators in the project life cycle (Yu et al., 2018)

SP	SC	Sub-SC	SI	Abbreviation	Unit	Project phases							
						I	P&D	C	M&C	TO	O	M	D
		E2b	E2b1	WPR	No	MI	I	VI	M	MI	M	MI	M
		E2c	E2c1	SWR	No	MI	M	I	M	MI	M	MI	M
		E2d	E2d1	MNR	No	MI	I	VI	I	MI	MI	MI	MI
		E2e	E2e1	AFT	No	MI	I	I	MI		M	MI	
			E2e2	GLP	%	MI	VI	VI	I	MI	M	MI	-
		E2f	E2f1	LGM	No	MI	VI	VI	M	-	VI	M	M
	E3	E3a	E3a1	RPA	%	MI	VI	VI	M	MI	M	M	
			E3a2	EOH	Y/N	I	VI	I	M	MI	M	MI	MI
		E3b	E3b1	ABA	Y/N	I	I	M	M	MI	MI	MI	MI
			E3b2	ADA	Y/N	I	I	M	M	MI	MI	MI	MI
		E3c	E3c1	VGP	Y/N	MI	I	I	MI	-	-	MI	-
S	S1	S1a	S1a1	AOA	Y/N	M	VI	MI	M	MI	M	MI	-
			S1a2	IOI	Y/N	M	VI	MI	MI	M	M	M	-
			S1a3	CGB	No	M	VI	I	M	I	I	MI	-
		S1b	S1b1	POD	Y/N	I	VI	M	MI	MI	MI	MI	-
			S1b2	PSS	Y/N	VI	VI	I	I	I	I	M	MI
	S2	S2a	S2a1	CCM	Y/N	M	I	M	MI	MI	I	I	I
	S3	S3a	S3a1	FAD	No	MI	VI	I	M	M	I	MI	
	S4	S4a	S4a1	PLR	Y/N	M	I	I	MI	-	MI	I	MI
			S4a2	FSB	Y/N	I	I	M	MI	MI	VI	-	-
EC	EC1	EC1a	EC1a1	RLE	%	MI	MI	I	MI	MI	I	MI	-
			EC1a2	SLR	%	I	M	VI	MI	MI	VI	-	-

Note. SP: Sustainable pillars; E: Environment; S: Social; EC: Economics; SC: Sustainability categories; Sub-SC: Sustainability sub-category; I: Initialization; P&D: Plan & design; C: Construction; M&C: Monitoring & control; TO: Turn over; O: Operation; M: Maintenance; D: Demolition; VI: Very important; I: Important; M: Medium; MI: Minor; & not all indicators are relevant and applicable in all phases of the project

Table 4. CPSAS with criterion (Yu et al., 2018)

SP	SC	Sub-SC	SI	Abbreviation of indicators	Criterion	Project phase
E	E1	E1a	E1a1	DAR	⩾ 60%	
		E1b	E1b1	RBS	⩽ 50%	
			E1b2	RCU	⩾ 40%	
		E1c	E1c1	MWS	⩾ 1	
			E1c2	MWR	⩾ 1	
		E1d	E1d1	MES	⩾ 1	
			E1d2	UGE	Y/N	
	E2	E2a	E2a1	APP	⩾ 1	
			E2a2	LAP	⩾ 1	
		E2b	E2b1	WPR	⩾ 1	
		E2c	E2c1	SWR	⩾ 1	
		E2d	E2d1	MNR	⩾ 1	
		E2e	E2e1	AFT	⩾ 1	
			E2e2	GLP	⩾ 10%	
		E2f	E2f1	LGM	⩾ 1	
	E3	E3a	E3a1	RPA	⩾ 40%	
			E3a2	EOH	Y/N	
		E3b	E3b1	ABA	Y/N	
			E3b2	ADA	Y/N	
		E3c	E3c1	VGP	Y/N	
S	S1	S1a	S1a1	AOA	Y/N	
			S1a2	IOI	Y/N	
			S1a3	CGB	⩾ 4	
		S1b	S1b1	POD	Y/N	
			S1b2	PSS	Y/N	
	S2	S2a	S2a1	CCM	Y/N	
	S3	S3a	S3a1	FAD	⩾ 1	
	S4	S4a	S4a1	PLR	Y/N	
			S4a2	FSB	Y/N	
EC	EC1	EC1a	EC1a1	RLE	⩾ 20%	
			EC1a2	SLR	⩾ 50%	

Table 5. The breakdown of questionnaires distribution

Respondents	ND	NRV	R&V (%)
Professional	78	62	79

Note. ND: No distributed; NRV: No returned and validated; & R&V(%): % returned and validate

METHODOLOGY

The research was designed in a way as to be able to assess the level of incorporation of SD principles into the design and construction of housing projects in Anambra State, Nigeria.

Based on the perception of key construction professionals. For this study, the researchers used a survey design in the form of structured questionnaires to obtain data from the field. The population of this study includes key professionals, involved in the built environment. The study is delimited to Awka, Anambra State, Nigeria.

The key professionals include architects (23), builders (18), civil/structural engineers (25), and quantity surveyors (12). The population of each profession was sourced from their respective state secretariats, which represents seventy-eight registered professionals in the study area. The population was maintained and used for the study due to its small size.

Questionnaires were administered to professionals (see **Table 5**). A total of seventy-eight questionnaires were distributed, while sixty were returned and found fit for the study, which corresponds to 79% returned. The respondent's views on the research questions were used to form opinions on the level of incorporation of SD principles into the design and construction of housing projects in Anambra State, Nigeria.

Data obtained from the questionnaire survey were analyzed and presented using mean-score, CPSAS, and tables. The overall project sustainability index (PSI) was calculated for a specific construction project. According to CPSAS, there are two types of indicators:

(1) Quantitative indicators: Measured by the percentage (%) of values or quantities of the indicators; and

(2) Non-quantitative indicators: Measured by 'yes or no (Y/N)' of the outcome of the indicators.

The two indicator types are aggregated in PSI using the Eq. (1), as follows:

$$PSI = \frac{\sum_{i=1}^{m} PSInq\ (i) + \sum_{J=1}^{n} PSImq(j)}{N+M} \times 100, \quad (1)$$

where *PSI* is in percentages (%), *N* is the number of quantitative indicators, *M* is the number of qualitative (non-quantitative) indicators, *PSInq (i)* is the evaluated result of the *i*th quantitative indicator, and *PSImq (j)* is the evaluated result of the j^{th} quantitative indicator.

The measurement was restricted to the construction phase of the housing project and fifteen indicators were measured. They include eight environmental sustainability indicators, six socio-cultural indicators, and one economic sustainability indicator.

Table 6. Perception of the respondents on PDA

Environmental indicator	Criterion ⩾ 60%				
	0 ⩾ 20%	> 20% ⩽ 40%	> 40% ⩽ 60%	> 60% ⩽ 80%	> 80% ⩽ 100%
PDA	0	0	0	62	0

Table 7. Perception of the respondents on RBS

Environmental indicator	Criterion ⩽ 50%				
	0 ⩾ 20%	> 20% ⩽ 40%	> 40% ⩽ 60%	> 60% ⩽ 80%	> 80% ⩽ 100%
RBS	0	0	0	0	62

Table 8. Perception of the respondents on RCU

Environmental indicator	Criterion ⩾ 40%				
	0 ⩾ 20%	> 20% ⩽ 40%	> 40% ⩽ 60%	> 60% ⩽ 80%	> 80% ⩽ 100%
RCU	0	0	0	62	0

RESULTS

Analysis and Measurement of the Perception of Respondents on the Level of Incorporation of Sustainable Development Principles in Housing Projects

This section analyses the results of the perception of respondents on the incorporation of SD indicators into housing projects and measures the results according to CPSAS.

The result shown in **Table 6** shows the perception of respondents on the level of incorporation of the project development area (PDA). It shows that 62 respondents, which represents 100% of the respondents indicated that over 60% to 80% of the project site has been built upon. This is according to the CPSAS which stated a criterion of ⩾ 60% of the project site is to be built. This indicates that the incorporation of PDA in the study area 'pass' the criterion on CPSAS.

The result in **Table 7** shows the perception of respondents on the level of ratio of borrowed soil (RBS) in the study area. The result shows that 62 respondents, which represent 100% of the total respondents indicated that over 80% to 100% of soil is borrowed off-site. This is according to CPSAS which states a criterion of ⩽ 50%. This indicates that the incorporation of RBS in the study area 'fail' to pass the criterion onto the CPSAS.

The result shown in **Table 8** shows the perception of the respondents on the use of concrete in housing projects in the study area. The result shows that 62 respondents, which represents 100% indicated that over 60% to 80% ratio of concrete usage. This is indicated according to the CPSAS which set a criterion of ⩾ 40% of the RCU. This indicates that the incorporation of RCU in the study area 'pass' the criterion on the CPSAS.

The result shown in **Table 9** shows the perception of the respondents on the incorporation of the ratio of planting area (RPA) in housing projects in the study area. 52 respondents which represent 84% of the total respondents indicated 0 ⩾ 20%, 8 respondents which represent 13% of the total respondents indicated > 20% ⩽ 40% and 2 respondents which represent 3% indicated > 40% ⩽ 60%.

Table 9. Perception of the respondents on RPA

Environmental indicator	Criterion ⩾ 40%				
	0 ⩾ 20%	> 20% ⩽ 40%	> 40% ⩽ 60%	> 60% ⩽ 80%	> 80% ⩽ 100%
RPA	52	8	2	0	0

Table 10. Perception of the respondents on the environmental principle of SD

Environmental indicator	Frequency					Mean	R11
	5	4	3	2	1		
MWS	0	0	0	8	54	1.13	0.23
MWR	0	0	0	0	62	1.00	0.20
MES	0	0	0	12	52	1.19	0.24
UGE	0	0	0	5	57	1.08	0.22

Table 11. Perception of the respondents on the socio-cultural principle of SD

Socio-cultural indicator	Frequency					Mean	R11
	5	4	3	2	1		
POD	31	31	0	0	0	4.5	0.90
PSS	0	28	0	21	13	2.69	0.54
MCC	22	40	0	21	13	4.03	0.81
FAD	0	15	0	35	12	2.30	0.46
PLR	9	23	0	30	0	3.18	0.64

The result shows that the majority of respondents represent 84% of the total respondents indicated 0-20%. This shows that the RPA is below 40. This indicates that the RPA 'fail' to pass the criterion on CPSAS.

The result shown in **Table 10** indicates the perception of respondents on the level of incorporation of the environmental principle of SD in the construction phase of housing projects. The result shows that the measure of water savings (MWS) had a mean score of 1.13 and RII of 0.23. The measure of water recycling (MWR) had a mean score of 1.0 and an RII of 0.20. The measure of energy savings (MES) had a mean score of 1.19 and an RII of 0.24. Usage of green energy (UGE) had a mean score of 1.08 and an RII of 0.22. The result indicates that MWS, MWR, MES, and UGE with mean scores of 1.13, 1.00, 1.19, and 1.08, respectively fail to pass the mean cut-off score of 3.0. As such it can be represented as a 'fail' in the criterion set as 'yes' on the CPSAS table.

The result shown in **Table 11** indicates the perception of respondents on the level of incorporation of socio-cultural indicators of the SD principle in the construction phase of housing projects. The result shows that prevention of disaster (POD) had a mean score of 4.5 and an RII of 0.90. Protection of stakeholders safety (PSS) had a mean score of 2.69 and an RII of 0.54. The measure of conserving cultural monuments (MCC) had a mean score of 4.3 and an RII of 0.81. Free access for the disabled had a mean score of 2.30 and an RII of 0.46. Participation of local residents (PLR) had a mean score of 3.18 and an RII of 0.64. Fair sharing benefit (FSB) had a mean score of 2.85 and an RII of 0.57. The result indicates that POD, MCC, and PLR with mean scores of 4.50, 4.03, and 3.18, respectively pass the mean cut-off score of 3.0 which also can be translated as 'pass' in the criteria on CPSAS. The result also shows that PSS, FAD, and FSB with mean scores of 2.69, 2.30, and 2.85, respectively, which fail to meet the mean cut-off score of 3.0. This can be translated as a 'fail' in the CPSAS.

Table 12. Perception of the respondents on RLE

Environmental indicator	Criterion ⩾ 40%				
	0 ⩾ 20%	> 20% ⩽ 40%	> 40% ⩽ 60%	> 60% ⩽ 80%	> 80% ⩽ 100%
RLE	0	32	15	15	0

Table 13. Overall PSI

SD indicator	Criteria	
	Pass	Fail
PDA	Pass	-
RBS	-	Fail
RCU	Pass	-
MWS	-	Fail
MWR	-	Fail
MES	-	Fail
UGE	-	Fail
RPA	-	Fail
POD	Pass	-
PSS	-	Fail
MCC	Pass	-
FAD	-	Fail
PLR	Pass	-
FSB	-	Fail
RLE	Pass	-
Total	**6**	**9**

Note. PSI = (Pass/total indicators) × 100 = (6/15) × 100 = 40% (low compliance and sustainability performance)

The result in **Table 12** shows the perspective of the respondents on the ratio of local employment (RLE) employed during the construction phase of the housing project. The result shows that 32 respondents indicated > 20% ⩽ 40%, 15 respondents indicated > 40% ⩽ 60%, and 15 respondents indicated > 60% ⩽ 80%. This indicates that the RLE is above 20% in the study area. This is according to the CPSAS which set up a criterion of ⩾ 20% of RLE. This indicates that the incorporation of RLE in the study area is above 20% which 'pass' the criterion on the CPSAS.

Analysis of the Overall Project Sustainability Index

This presents the analysis and results of the measurement using the CPSAS.

The results shown in **Table 13** contained results obtained from **Table 2-Table 8**. It included 15 measured indicators on environmental pillars/principles (PDA, RBS, RCU, MWS, MWR, MES, UGE, and RPA), socio-cultural pillars/principles (POD, PSS, MCC, FAD PLR, and FSB), and economic pillar/principle (RLE). The result shows that 6 indicators, PDA, RCU, POD, MCC, PLR, and RLE 'pass' criteria on CPSAS based on the perception of respondent's responses. While 9 indicators were RBS, MWS, MWR, MES, UGE, RPA, PSS, PAD, and FSB 'fail' to pass their criteria on the CPSAS. The overall PSI, therefore, represents 40% and it is ranked 'low sustainability level' of compliance of SD principles in the study area.

CONCLUSIONS

Based on the findings, it is concluded that the concept of SD has not fully been incorporated into housing project delivery in the study area which was confirmed by the PSI to be 40% level of compliance. It is perceived that SD is normative, subjective, and ambiguous. Hence, there should be more education sponsored by all stakeholders (in terms of awareness, training, and information) on SD. Socio-cultural, economic, and environmental degradation must be tackled in a more integrated and holistic way, hence, the government of Anambra state should formulate and implement social, economic, and environmental policies for housing project delivery. This would ensure that the incorporation of these policies would facilitate and foster environmental, economic, and social inclusion in sustainable housing project delivery. Further studies need to be carried out in developing an indigenous assessment system for researchers, to properly evaluate the level of incorporation of different dimensions of SD principles in housing projects in Anambra State and other states of Nigeria

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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