Journal of Environmental & Earth Sciences
https://journals.bilpubgroup.com/index.php/jees

ARTICLE

Material Selection and Climate Change

George Sarpong-Nsiah [1*], *Amevi Acakpovi* [2]

[1] *Civil Engineering Department, Accra Institute of Technology, Accra P.O. Box AN-19782, Ghana*
[2] *Electrical Engineering Department, Accra Technical University, Accra P.O. Box GP 561, Ghana*

ABSTRACT

This paper deals with carbon emissions reduction through building material selection in housing construction using Analytical Hierarchy Process (AHP) method. Drawing on the concept of Sustainable Development in the Environment (SDE), inadequate selection of building materials makes a significant contribution to carbon emissions. The achievability of the goal of SDE is in rethinking Locally Sourced and Recycled Building Materials (LSRBMs) selection decision making, in acknowledging cultural issues, towards the wider industrial use of Recycled Concrete Crushed Block Wall (RCCBW) which is about 66%, in carbon emissions, as good as Air-crete Hollow Block Wall (AHBW). With results derived from questionnaire survey with recruited civil engineers and architects, key sustainability principle indicators influencing the selection of building materials are identified, analysed, grouped and ranked using AHP, a concept of measurement through pairwise comparisons of tangible and intangible factors to derive priority scales in relative terms. This explained 17.27% cut back in carbon emissions for selecting Compressed Stabilized Rammed-Earth Block Wall (CSREBW) instead of AHBW. The lack of informed knowledge in the wider use of RCCBW and CSREDW and in the Ghanaian context towards future reduction in carbon emissions in the housing sector of the construction industry of Ghana. Subsequently, the study yielded the following theoretical, practical and policy implications: A new interpretation of existing building

*CORRESPONDING AUTHOR:
George Sarpong-Nsiah, Civil Engineering Department, Accra Institute of Technology, Accra P.O. Box AN-19782, Ghana;
Email: ingnsiah@gmail.com

ARTICLE INFO
Received: 14 March 2025 | Revised: 4 June 2025 | Accepted: 10 June 2025 | Published Online: 9 January 2026
DOI: https://doi.org/10.30564/jees.v8i1.9051

CITATION
Sarpong-Nsiah, G., Acakpovi, A., 2026. Material Selection and Climate Change. Journal of Environmental & Earth Sciences. 8(1): 18–28. DOI: https://doi.org/10.30564/jees.v8i1.9051

materials; Understanding the impact of building materials' attributes; In effect, might be beneficial to universities and organizations to come up with training policies that aim to take advantage of the new technology respectively.
Keywords: Analytical Hierarchy Process; Building Materials; Carbon Emissions; Factors; Variables; Criteria; Housing Construction

1. Introduction

The complexity of interactions between construction and natural environment and its influence has raised a broad range of international awareness [1]. A growing concern is the extent of environmental deterioration that exacerbate economic equity driving the current world focus on sustainability in environmental development. The arrangement and distribution of different elements within the landscape of Sub-Saharan Africa (SSA), such as environmental degradation survey, its causalities, and future impacts of climate change are investigated through approaches, scales of measurements, and characteristic aspects. Although scientific research on climate change has been intensified in SSA, there have been little systematic efforts by local actors and stakeholders. Using the example of Ghana, this research intends to answer the question—whether Production of Compressed Stabilized Rammed-Earth Block Wall (CSREBW) and Recycled Concrete Crushed Block Wall (RCCBW) require much less energy and had a lower net environmental impact than Air-crete Hollow Block Wall (AHBW) and therefore whether our claim that CSREBW & RCCBW are sustainable was legitimate.

2. Technology in Material Selection: A State-of-the-Art

The central concept represents the core focus of the research, with the connecting theories providing foundational perspectives and insights relevant to specific research objectives.

2.1. Theoretical Framework

The Normative Neoclassical Economic (NNE) theory dominant streams: (1) Caroll and Johnson's [2] theory seeks consistent preferences from decision makers and reminds them of the need to know the long-term economic effects of their preferences; and (2) Monetary value put on the environmental effects through informed economic decisions, provide a framework for comparing the environmental loss with economic gains. To this effect, basic economic struggle can take precedence over environmental sustainability. Subsequently, drawing from the generic definition provided by Van Pelt [3] and Boyd [4], it is contended that economic and environmental measures should appropriately and explicitly be redefined as the long-term financial impact of housing projects when selecting building materials and general conditions promoting the completion and sustenance of a housing project without major accidents or injuries to users respectively.

Furthermore, the relationship between individuals and the environment is determined by the interpretation of cost of living and standard of living by a community [5]. Economic and environmental sustainability are linked and the social component need to be brought into balance [6]. Mud used in a plastic state to erect an earthen wall in the southern part of Ghana would not export well to the northern part of Ghana due to its proximity to the Sahara Desert. Therefore, sociocultural should appropriately and explicitly be redefined as the architecture of the region, as well as promote the image of the community.

2.2. Empirical Review: Material Selection MTFs

Ding et al. [7] introduced a comprehensive material selection Methods, Tools or Framework (MTFs) that measures and quantifies the lifecycle environmental characteristics of a building material using verifiable set of criteria to achieve low-environmental impact. However, it appears directly to sustainable material selection towards environmental issues. Comprehensive Assessment Systems for Building Environmental Efficiency (CASBEE) is based on the building's life cycle such as pre-design, new construction, existing buildings, and renovation. A relationship between environmental load and quality is characterized by low-environmental impact of construction material [8]. However, it is developed for the Japanese market just as the Green Star and Building Research Establishment's Environmental Assessment Method (BREEAM) are a case-based reasoning of the developer and country of origin.

Furthermore, Multi-Criteria Analysis (MCA) is not widely used to aid building material selection decision-making in housing construction that directly force a shift in material selection [9,10]. Van-Pelt's study on material selection MTFs investigated user adoption from a single-criterion approach such as energy usage, with little recourse to multi-criteria approach. This study addresses the empirical gap from a multi-criteria approach. MCA deal with quantitative, qualitative or mixed data for both discrete and continuous choice problems and does not have a ceiling for the number of criteria. Therefore, MCA is a more realistic and ideal methodological framework for the development of the 'carbon dioxide utility index'.

2.3. Empirical Review: Contradiction

MacDowell et al. [11] established that continued growth in anthropogenic CO_2 emissions requires attention, given that the rate of CO_2 production versus its chemical conversion will account for less than 1% of the mitigation challenges thus, a costly distraction from the real task of CO_2 emissions reduction. Anthropogenic CO_2 emissions in the period 2000–2014 grew at 2.6% per year, facing irreversible harm [12,13]. Every year of the century has seen a year-on-year increase in anthropogenic CO_2 emissions with a positive relationship between anthropogenic CO_2 production and warming characterized by increase in earth's temperature above pre-industrial levels. Exceeding 1.5 °C warming possess risk of irreversible tipping points [14]. The direct effect of climate change extends beyond heat to include extremes of weather, clean air, safe drinking water, and compromising food security and by the year 2060 climate will cause average global income losses by 19% [15,16]. For example, in 2017, a total of 712 extreme weather events resulted in US $326 billion in economic losses almost triple the total losses of 2016. On the contrary, Abdussamatov [17] established no correlation between continued increased in natural production of CO_2 and warming/cooling, given that warming and cooling is a cyclic occurrence due to space forces beyond our control. To suggest that a clear understanding of change in climate in the past will offer an opportunity to study and deal with future changes in climate quasi-periodic changes in the Sun's output can lead to significant changes in the Earth's climate. However, Abdussamatov's promotion of "Solar-driven Cooling" hypothesis is not supported by empirical data.

Furthermore, the Ghana building code approves mud used in a plastic state, earth rammed between wooden, unburnt earth bricks, sandcrete blocks, and stabilized earth blocks to erect a wall. Ghana classifies dwelling units into 51.5% compound houses, 28.7% separate houses, 7.1% semi-detached houses, 4.7% flat/apartments, and 8% others [18]. Also, the materials selected for roofing are 71.4% metal sheet, 13.0% slate/asbestos, 8.6% thatched, and 7.0% others [19]. To this effect, the type of material selected depends on the engineering-designed function.

2.4. Empirical Review: Conceptual Framework/Model

The outline of a conceptual framework for measuring CO_2 emissions of LSRBMs selection for office building developments starts with the identification of factors, strategies, drivers and barriers. For the purpose of clarity, the key factors are compressed into environmental impact, economic efficiency, and socio-cultural benefits. **Figure 1**, a visual tracking of the conceptual framework of the analysed decision factors for measuring CO_2 of LSRBMs for office building developments. As it can be seen from **Figure 2**, a conceptual model with determinant such as sociocultural intangible factors, and environmental and economic tangible factors to measure CO_2 emissions LSRBMs housing projects.

3. Materials and Methods

The research method to collect data for analysis and the theoretical frameworks informing the choice of the method related to investigate an indexing algorithm termed 'carbon dioxide utility index' to rank options of competing building material choices on their contribution to future reduction in carbon emissions.

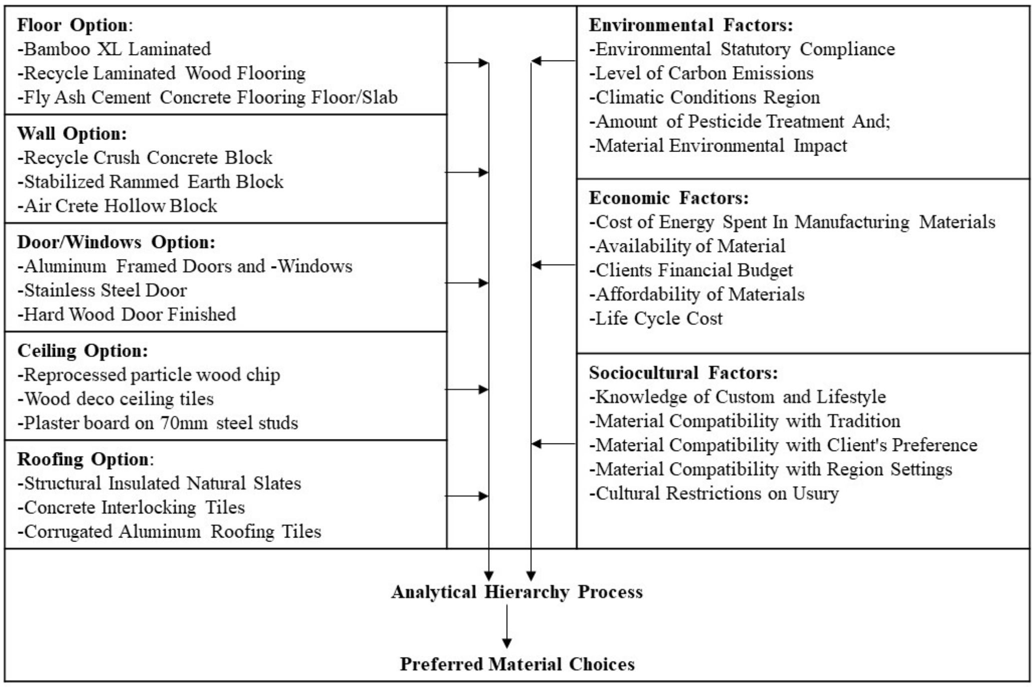

Figure 1. Conceptual framework of analyzed decision factors for measuring CO_2 emissions of LSRBMs for office building developments sector of the construction industry of Ghana.

Source: Sarpong-Nsiah et al. [6].

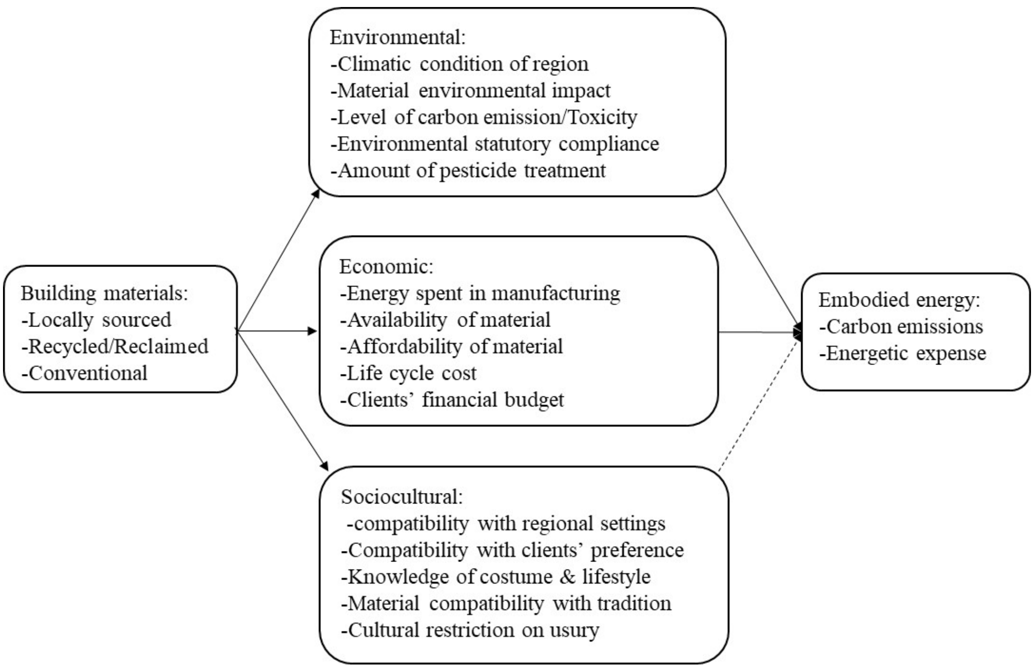

Figure 2. The research model developed for the study derived the constructs from the NNE theory.

3.1. Research Paradigm

Positivism and interpretivist provide a platform for research methodology adopted and techniques to be used. Research methodologies can either assume a quantitative or qualitative approach. The strength in combining both qualitative and quantitative research methods to improve the quality of the research have been widely acknowledged [20,21]. Hence, the choice of the mixed method for this study. Furthermore, adopting positivism either case study or survey would be the most ideal method. In surveys, samples are examined through questionnaires while case study involve an empirical enquiry that investigates a contemporary occurrence within a real-life context. The theoretical basis of this study involved collecting data to draw a deductive conclusion. In view of this a survey technique was chosen as the most appropriate method.

3.2. Review

Providing a clear theoretical framework for a relatively new area of study, we examined relevant literature, using a range of information collection tools such as books, peer-reviewed journals, and internet-based sources. This task helped us to confirm initial observations, and develop preliminary ideas on issues specific to environmental, economic, and socio-cultural. We had insights into knowledge deficits of various material selection MTFs.

3.3. Synthesis

We needed to learn about problems that does not have a wealth of published information. This served as a means of looking at a far greater number of variables than is possible with literature review. The composition of 690 engineers and 810 architects making a population size of 1500 was considered. Choosing a sample size of 400, we have to select 184 from the engineers and 216 from the architects. Stratified random sample ensured homogeneity and improved quality of the data gathered, and achieving sampling equivalence amongst different groups. Snow ball technique was used to improve response rate.

3.4. Operationalization

Drawing on the constructs identified in the conceptual model, the appropriate dependent and independent variables for the survey instrument were operationalized. Key sustainability principle and building material attributes reflect repetitive design intuition in the housing sector of the construction industry of Ghana. The concept provided insights into knowledge deficits of various material selection MTFs. Therefore, the respondents' attention was drawn to the significance of repetitive planning technique in the wording of the questions. Subsequently, a total of fifteen variables common in the construction industry of Ghana were identified as level of carbon emissions, climatic conditions of region, pesticide treatment, environmental statutory compliance, material environmental impact, energy spent in manufacturing, availability of the material, life cycle cost, clients financial budge, affordability of the materials, knowledge of costume and life style, material compatibility with tradition, compatibility with client's preference, material compatibility with regional settings, and cultural restriction and usury.

3.5. Reliability and Validity

Correcting potential errors on time and identify additional variables, we sent 30 pilot questionnaires to individuals in the building construction industry of Ghana to complete the survey. Out of the 30 pilot questionnaires sent out to the selected sample, 15 were returned representing a response rate of 50%. Pretesting the survey enabled the study to test whether the questions were clear and understandable, to identify of flaws, to test the comprehensibility of the list of proposed decision selection factors, and to ensure that the wordings of the questionnaire could be reliably interpreted. The feedback suggestions were strictly followed to ensure the reliability and validity of the instrument. It was then ready for deployment for the main survey.

Consistency Ratio (CR) can be expressed as a ratio of Consistency Index (CI) to Random Index (RI) obtained from a large number of simulation run and varies depending upon the order of the matrix. If the value of CR is less than 10%, it implies that the evaluation within the matrix is acceptable or indicates a good level of consistency in the comparative judgements represented in that matrix. In contrast, if CR is more than 10%, inconsistency of judgements within that matrix has occurred and the evaluation process should therefore be reviewed, reconsidered and improved. An acceptable consistency helps to ensure reliability in the determination of priorities of a set of criteria, in handling the complexities of a real-world problem [22].

3.6. Data Analysis and Technique

We used the Analytical Hierarchical Process (AHP) method in selecting, weighting, standardizing and aggregating environmental, economic and socio-cultural criteria into a composite index. AHP compares criteria by pairs and assigns weights to derive priority scales. The AHP calculates the inconsistency index as a ratio of the decision maker's inconsistency and randomly generated index. The method's ability to measure and synthesize the unlimited number of factors within the developed hierarchy that truly sets the method apart [23].

4. Results

The goal is rethinking LSRBMs for future reduction of CO_2 emissions with a potential for climate change mitigation as spelt out by the criteria in **Table 1** and **Figure 3**:

Table 1. Summary of the wall option.

Wall Option	A	B	C
Engineering designed Function	Recycled Concrete Crushed Block Wall	Compressed stabilized rammed-earth block wall	Air-crete hollow block wall
Size of material	75 × 125 mm	150 × 225 mm	225 × 225 mm
Rate of CO_2 emissions	0.02 $kgCO_2/m^2$	0.073 $kgCO_2/m^2$	0.3 $kgCO_2/m^2$

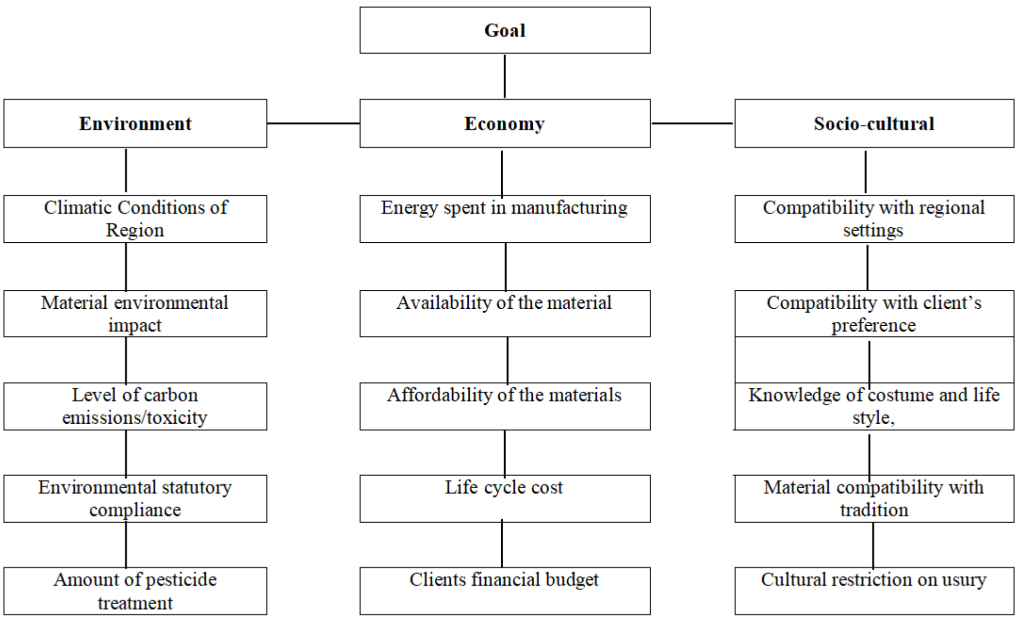

Figure 3. Appropriate material selection decision.

4.1. Process Analysis and Design

This section will analyse the problem using the AHP mathematical multi-criteria decision-making technique to identify and decide which wall option causes a low-environmental impact and a sustainable building material for a proposed residential separate house. The three wall options for the proposed separate house was based on the Ghana building code and were analysed amongst a host of other building material alternatives.

4.1.1. Analysis Requirements

Decomposition of the decision making process. One for the criteria with respect to the goal, which is shown in **Table 2**, three for the sub-criteria with respect socio-cultural, economic, and environmental tables (**Tables 3–5** respectively).

Table 2. Pairwise comparison matrix of the main criteria with respect to the goal.

	Sociocultural	Environmental	Economic	Priorities
Sociocultural	1	0.14	0.33	0.0878
Environmental	7	1	3	0.6544
Economic	3	0.33	1	0.2578

Note: CI = 0.004, RI = 0.580, CR = 0.007 < 5%.

Table 3. Pairwise comparison matrix for the factors with respect to sociocultural.

	Compatibility with Regional Settings	Compatibility with Client's Preference	Knowledge of Costume and Life Style	Material Compatibility with Tradition	Cultural Restriction on Usury	Priority
Compatibility with regional settings	1	3	1	2	3	0.2612
Compatibility with client's preference	0.33	1	1	6	2	0.2699
Knowledge of costume and life style	1	1	1	4	5	0.3135
Material compatibility with tradition	0.50	0.17	0.25	1	1	0.0762
Cultural restriction on usury	0.33	0.5	0.20	1	1	0.0792

Note: CI = 0.103, RI = 1.120, CR = 0.092.

Table 4. Pairwise Comparison Matrix for the Factors with Respect to Economic.

	Availability of Material	Cost of Energy Spent in Manufacturing	Life Cycle Cost	Affordability of the Materials	Clients' Financial Budget	Priority
Availability of material	1	3	1	3	5	0.3028
Cost of energy manufacturing	0.33	1	1	6	2	0.2407
Life cycle cost	1	1	1	4	7	0.3261
Affordability of the Materials	0.33	0.17	0.25	1	1	0.0641
Clients' financial budget	0.20	0.5	0.14	1	1	0.0662

Note: CI = 0.053, RI = 1.120, CR = 0.047 < 10%.

Table 5. Pairwise comparison matrix for the factors with respect to environment.

	Environmental Statutory Compliance	Amount of Pesticide Treatment	The Climatic Condition of the Region	Level of Carbon Toxicity	Material Environmental Impact	Priority
Environmental Statutory Compliance	1	3	1	2	5	0.2919
Amount of pesticide treatment	0.33	1	1	6	2	0.2513
Climatic Condition of the Region	1	1	1	4	6	0.3162
Level of carbon toxicity	0.50	0.17	0.25	1	1	0.0709
Material Environmental Impact	0.20	0.5	0.17	1	1	0.0697

Note: CI = 0.109, RI = 1.120, CR = 0.097 < 10%.

4.1.2. Process Design

To find the final global weight of each sub-criterion, the results of the weighting vector for standing carbon dioxide emission criteria list were arranged (**Table 6** and **Figure 4**). The main criteria weighting vectors (1) are multiplied by the corresponding sub-criteria weighting vectors (2) to obtain the (global) criteria weight (3). The nine (9) highest weighted sub-criteria for standing list: 5 out of 5 environmental, 3 out of 5 economic, and 1 out of 5 sociocultural. Thus, socio-cultural factors are implicit. The final step in the pair-wise comparison involves comparing each pair of alternatives with respect to each sub-criterion. In comparing the three flooring materials, the decision-makers were asked which material is preferred with respect to each sub-criterion. They are represented by letters A, B and C (**Tables 7–9**).

Table 6. Priority weights for CO_2 emission main criteria and sub-criteria.

Main Criterion	Main Criterion Weight	Sub-Criterion	Sub-Criterion Weight	Global Weight
Sociocultural	0.08782	Compatibility with regional settings	0.2612	0.02294
		Compatibility with client's preference	0.2699	0.02370
		Knowledge of costume and life style	0.3135	0.02753
		Material compatibility with tradition	0.0762	0.00669
		Cultural restriction on usury	0.0792	0.00696
Economy	0.25779	Availability of material	0.3028	0.07807
		Energy spent in manufacturing	0.2407	0.06206
		Life cycle cost	0.3261	0.08408
		Affordability of the Materials	0.0641	0.01651
		Clients financial budget	0.0662	0.01707
Environmental	0.65439	Environmental statutory compliance	0.2919	0.19099
		Pesticide treatment required	0.2513	0.16446
		Level of carbon emissions/Toxicity	0.0709	0.04642
		Climatic conditions of region	0.3162	0.20690
		Material Environmental Impact	0.0697	0.04562
	1		3	1

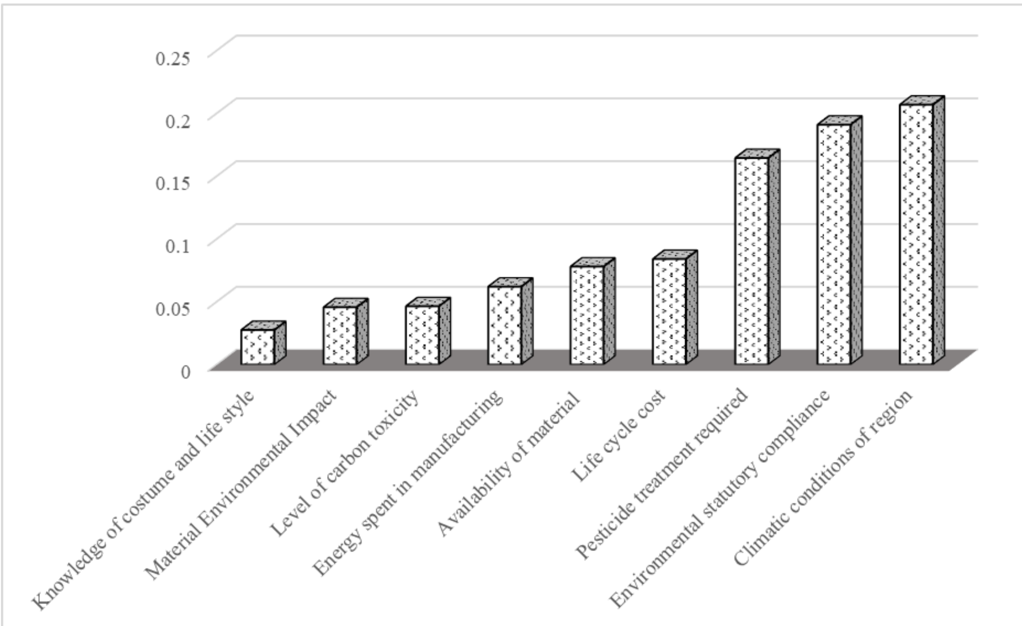

Figure 4. Nine highest analysed factors for measuring CO_2 emissions.

Table 7. Pairwise comparison matrix for the material with respect to Climatic conditions of region, Environmental statutory compliance, and Pesticide treatment required.

Climatic Conditions of Region					Environmental Statutory Compliance					Pesticide Treatment Required				
	A	B	C	Priorities		A	B	C	Priorities		A	B	C	Priorities
A	1	0.14	3	0.2218	A	1	3	5	0.3913	A	1	1	0.33	0.2154
B	7	1	0.20	0.4391	B	0.33	1	3.00	0.1884	B	1	1	0.50	0.2308
C	0.33	5	1	0.3391	C	0.20	0	1	0.0667	C	3	2	1	0.5538

Table 8. Pairwise comparison matrix for the material with respect to Life cycle cost, Availability of material, and Energy spent in manufacturing.

Life Cycle Cost					Availability of Material					Energy Spent in Manufacturing				
	A	B	C	Priorities		A	B	C	Priorities		A	B	C	Priorities
A	1	1	0.33	0.2000	A	1	7	5	0.7496	A	1	1	0.11	0.0949
B	1	1	0.33	0.2000	B	0.14	1	1	0.1236	B	1	1	0.13	0.0956
C	3	3	1	0.6000	C	0.20	1	1	0.1269	C	9	8	1	0.8095

Table 9. Pairwise comparison matrix for the material with respect to Level of carbon emissions/Toxicity, Material Environmental Impact, and Knowledge of costume and life style.

	Level of Carbon Emissions/Toxicity					Material Environmental Impact					Knowledge of Costume and Life Style			
	A	B	C	Priorities		A	B	C	Priorities		A	B	C	Priorities
A	1	0.50	0.11	0.0741	A	1	0.50	0.20	0.1069	A	1	1	0.11	0.0949
B	2	1	0.14	0.1445	B	2	1	0.20	0.2013	B	1	1	0.13	0.0956
C	9	7	1	0.7815	C	5	5	1	0.6918	C	9	8	1	0.8095

As can be seen from **Table 10**, all criteria are amalgamated to create an indexing algorithm termed the 'carbon dioxide utility index' to rank options of competing material choices on their contribution to future reduction in CO_2 emissions. These priorities are each divided by the largest one to obtain the ideal priorities. It means that material options 'A' and 'B' are about 66% and 57% as good as material option 'C' respectively.

Table 10. Overall carbon dioxide index score.

Main Criteria	Main-Criterion Weight	Sub-Criterion	Sub-Criterion Weight	Global Weight					
				A	B	C	A	B	C
Sociocultural	0.0878	Knowledge of costume and life style	0.3135	0.0949	0.0956	0.8095	0.002612	0.002631	0.022282
Economic	0.2578	Availability of material	0.30285	0.7496	0.1236	0.1269	0.058525	0.00965	0.009908
		Energy spent in manufacturing	0.24072	0.0949	0.0956	0.8095	0.005889	0.005933	0.050236
		Life cycle cost	0.32614	0.2000	0.2000	0.6000	0.016816	0.016816	0.050447
Environmental	0.6544	Climatic conditions of region	0.3162	0.2218	0.4391	0.3391	0.045895	0.090859	0.070167
		Environmental statutory compliance	0.2919	0.3913	0.1884	0.0667	0.074746	0.035988	0.012741
		Pesticide treatment required	0.2513	0.2154	0.2308	0.5538	0.035423	0.037955	0.091073
		Level of carbon emissions/Toxicity	0.07094	0.0741	0.1445	0.7815	0.00344	0.006708	0.03628
		Material Environmental Impact	0.06972	0.1069	0.2013	0.6918	0.004877	0.009184	0.031563
Carbon dioxide utility index (Normalized priorities)							0.248223	0.215725	0.374696
Carbon dioxide utility index (Idealized priorities)							0.662465	0.575733	1

5. Discussion

Anthropogenic CO_2 emissions call for actions to keep threats of vicious cycle of poverty in developing countries at a moderate rather than extreme levels, setting emissions reduction from the building materials' sector to stay at 1.5 °C [24]. Each construction material is manufactured from some combination of raw materials with some emissions of CO_2. The inadequate construction materials' selection implies CO_2 emission increase [25]. Generally, this research indicates that research towards sustainable development in the environment in acknowledging the role of socio-cultural as vital resources for strengthening the material selection decision-making process for future reduction in carbon emissions has not been vigorously pursued in practice. We chose three building materials and compared them in a wall designed for the same engineering function. The wall used here did not allow to include any differences in durability of the 3 building materials. This estimation showed that Recycled Concrete Crushed Block Wall and compressed stabilized rammed-earth block wall have less environmental impact than Air-crete hollow block wall when compared in a wall designed for the same engineering function in the context of carbon reduction. It is difficult to answer the question of whether Recycled Concrete Crushed Block Wall and compressed stabilized rammed-earth block wall are sustainable building materials. We found no criteria to evaluate sustainability; however, we can conclude that compressed stabilized rammed-earth block wall and recycle concrete crushed block wall is more sustainable than air-crete hollow block wall (**Table 11** and **Figure 5**).

Table 11. Normalized Priorities and Idealized Priorities.

	Normalized Priorities	Idealized Priorities (%)	Reduction of Carbon Dioxide (%)
Recycle concrete crushed block wall 0.02 $kgCO_2/m^2$	0.248223	66.25	19.88
Compressed stabilized rammed-earth block wall 0.073 $kgCO_2/m^2$	0.215725	57.57	17.27
Air-crete hollow block wall 0.3 $kgCO_2/m^2$	0.374696	1	0

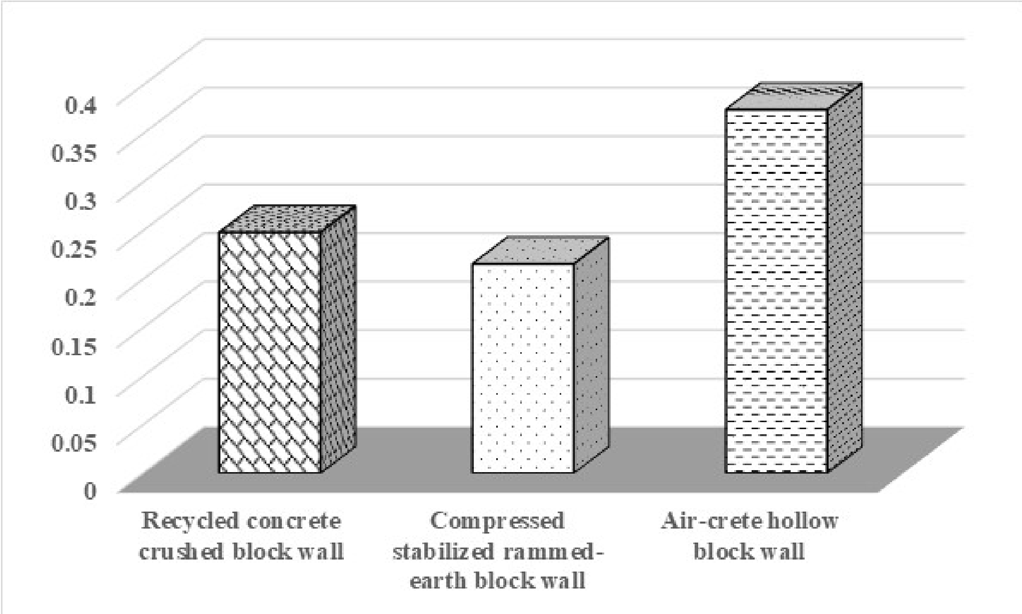

Figure 5. Wall Option.

6. Conclusion

The environmental impact of Recycle concrete crushed block wall and compressed stabilized rammed-earth block wall designed for the same engineering function was estimated using AHP-model. Based on this estimation, compressed stabilized rammed-earth block wall is about 58% as good as Air-crete hollow block wall (cut back of 17.27% carbon emissions) and recycle concrete crushed block wall is about 66% as good as Air-crete hollow block wall (cut back of 19.88% carbon emissions). Compressed stabilized rammed-earth block wall and recycle concrete crushed block wall exhibit lower net environmental impact than air-crete hollow block wall. Subsequently, this will help designers in a new interpretation of building materials and as a primary locus for further refinement of existing models. This will promote best practice guide in LSRBMs appraisal and will stimulate motivation of its wider industry use. In effect might guide building professional bodies based in Ghana to promote material selection good practices that offers healthy competition to players and at the same time offers value to designers.

Author Contributions

G.S.-N.: prior research study, research method phases, statistical and mathematical analysis, protocol write-up, draft, and manuscript. A.A.: supervised the analysis of the study. Both authors have read and agreed to the published version of the manuscript.

Funding

This work received no external funding.

Institutional Review Board Statement

The study was approved by the Accra Institute of Technology/Open University of Malaysia.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Unavailable due to ethical restriction and privacy.

Acknowledgments

We thank the Accra Institute of Technology and the Accra Technical University research centers for their immense contributions towards this work.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Intergovernmental Panel on Climate Change (IPCC), 2021. Climate Change 2021: The Physical Science Basis. IPCC: New York, NY, USA. pp. 3–32.

[2] Carroll, J.S., Johnson, E.J., 1990. Decision Research: A Field Guide. SAGE Publications: Thousand Oaks, CA, USA.

[3] Van Pelt, M.J.F., 1994. Environment and project appraisal: Lessons from two cases. The Annals of Regional Science. 28(1), 55–76.

[4] Boyd, J., 2007. Nonmarket benefits of nature: What should be counted in green GDP? Ecological Economics. 61(4), 716–723.

[5] Du Plessis, C., 2007. A strategic framework for sustainable construction in developing countries. Construction Management and Economics. 25, 67–76.

[6] Sarpong-Nsiah, G., Acakpovi, A., Aggrey, G.K., 2021. A multi-criteria approach for energetic expense cut back through climate-friendly material selection for office building development: A conceptual framework. In Proceedings of the 2021 IEEE 8th International Conference on Adaptive Science and Technology (ICAST), Accra, Ghana, 25–26 November 2021. DOI: https://doi.org/10.1109/ICAST52759.2021.9682035

[7] Ding, L., Quercia, R., Li, W., et al., 2010. Risky Borrowers or Risky Mortgages Disaggregating Effects Using Propensity Score Models. Journal of Real Estate Research. 33(2), 245–278. DOI: https://doi.org/10.1080/10835547.2011.12091305

[8] Suzuki, M., Oka, T., Okada, K., 1995. The estimation of energy consumption and CO_2 emissions due to housing construction in Japan. Energy and Buildings. 22(2), 167–169.

[9] United Nations Environment Programme (UNEP), 2022. Policy Pathways to Decarbonize Building Construction: A Global Review of Frontrunner Regulations. Global Alliance for Buildings and Construction: Paris, France.

[10] Sarpong-Nsiah, G., 2023. A multi-criteria optimization model for office building development through climate-friendly material selection: A conceptual framework. In Advances in Environmental Research. Nova Science Publishers: New York, NY, USA.

[11] MacDowell, N., Florin, N., Buchard, A., et al., 2010. An overview of CO_2 capture technologies. Energy and Environmental Science. 3(11), 1645–1669.

[12] Watts, N., Amann, M., Arnell, N., et al., 2018. The 2018 report of the Lancet Countdown on health and climate change: Shaping the health of nations for centuries to come. The Lancet. 392, 2479–2514.

[13] Romanello, M., di Napoli, C., Green, C., et al., 2023. The 2023 report of the Lancet Countdown on health and climate change: The imperative for a health-centered response in a world facing irreversible harms. The Lancet. 402(10419), 2346–2394.

[14] McKay, D.I.A., Staal, A., Abrams, J.F., et al., 2022. Exceeding 1.5°C global warming could trigger multiple climate tipping points. Science. 377(6611). DOI: https://doi.org/10.1126/science.abn7950

[15] Kotz, M., Levermann, A., Wenz, L., 2024. The economic commitment of climate change. Nature. 628, 551–557.

[16] Richard, C.E., Lupton, R.C., Allwood, J.M., 2021. Re-framing the threat of global warming: An empirical causal loop diagram of climate change, food insecurity, and social collapse. Climatic Change. 164, 371–400.

[17] Abdussamatov, H., 2024. Most of the Long-Term Solar Radiation Forcing on the Climate Is Due to the Strong Feedback Mechanisms. Journal of Environmental and Earth Sciences. 6(3), 6502. DOI: https://doi.org/10.30564/jees.v6i3.6502

[18] Owusu, G., 2010. Urban Growth, Globalization and Access to Housing in Ghana's Largest Metropolitan Area, Accra. Institute of Statistical, Social and Economic Research (ISSER): Legon, Ghana.

[19] UN-Habitat, 2011. Affordable Land and Housing in Africa. UN-Habitat: Nairobi, Kenya.

[20] Creswell, J.W., 2008. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 3rd ed. Sage Publications: Thousand Oaks, CA, USA.

[21] Creswell, J.W., Creswell, J.D., 2018. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage Publications: Thousand Oaks, CA, USA.

[22] Saaty, T.L., 1994. Fundamentals of Decision-Making and Priority Theory with the Analytic Hierarchy Process. RWS Publications: Pittsburgh, PA, USA.

[23] Saaty, T.L., 2007. Time dependent decision-making: Dynamic priorities in the AHP/ANP: Generalizing from points to functions and from real to complex variables. Mathematical and Computer Modeling. 46(7–8), 860–891.

[24] International Energy Agency (IEA), 2025. The 2025 IEA Net Zero Roadmap Update: The Role of Construction Materials. IEA: Paris, France.

[25] International Living Future Institute (ILFI), 2024. The 2024 ABC—Assessment of Building Circulatory: A Global Framework for Quantifying the Circularity and Carbon Footprint of Building Materials. International Living Future Institute (ILFI): Seattle, WA, USA.