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Assessment Of Circular Economy Potential of Interlocking Stabilized Soil Block Technology in Sustainable Construction

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Abstract-* The construction industry is increasingly adopting sustainable technologies to improve resource efficiency and reduce environmental impacts. Among these, Interlocking Stabilized Soil Block (ISSB) technology offers a sustainable alternative to conventional building materials by utilizing locally available resources, reducing construction waste, and lowering carbon emissions. However, limited research has examined its potential within the circular economy. This study assesses the circular economy potential of ISSB technology by evaluating its contribution to resource efficiency, waste reduction, material reuse, environmental sustainability, and economic viability. A quantitative research approach will be employed using structured questionnaires administered to architects, engineers, builders, and contractors familiar with ISSB technology. Data will be analyzed using descriptive and inferential statistics. The findings are expected to demonstrate that ISSB technology supports circular economy principles and promotes sustainable construction practices. The study will provide recommendations for construction professionals and policymakers to encourage the adoption of ISSB technology in sustainable building projects.

Keywords: Circular Economy, Interlocking Stabilized Soil Block (ISSB), Sustainable Construction, Resource Efficiency, Waste Reduction.

I. INTRODUCTION

Background to the Study

The construction industry is one of the largest contributors to global economic development. It provides infrastructure for housing, transportation, healthcare, education, and industrial activities. However, the industry is also one of the highest consumers of natural resources and a major generator of construction and demolition waste. Conventional building materials such as fired clay bricks, cement blocks, and reinforced concrete require significant amounts of energy during production, resulting in high greenhouse gas emissions and environmental degradation.

In response to these environmental challenges, the concept of the circular economy has gained increasing attention. Unlike the traditional linear economy, which follows the pattern of "take, make, and dispose," a circular economy focuses on reducing waste, reusing materials, recycling resources, and extending the life cycle of products. Applying circular economy principles in the construction industry promotes efficient resource utilization, minimizes environmental impacts, and supports sustainable development.

One innovative building technology that aligns with circular economy principles is the Interlocking Stabilized Soil Block (ISSB) system. ISSBs are compressed earth blocks produced from locally available soil mixed with a small percentage of cement or other stabilizing agents. The blocks are designed with interlocking edges, allowing them to fit together without requiring thick mortar joints. This reduces cement consumption, construction waste, labour costs, and construction time.

The use of ISSB technology offers numerous environmental, economic, and social benefits. Environmentally, it reduces dependence on fired bricks and concrete blocks, lowering carbon emissions and conserving natural resources. Economically, it utilizes locally available materials, thereby reducing transportation costs and creating employment opportunities within local communities. Socially, it promotes affordable housing by lowering construction costs while maintaining structural integrity and durability.

Despite these advantages, the adoption of ISSB technology remains relatively low in many developing countries due to limited awareness, lack of technical expertise, inadequate policy support, and public preference for conventional building materials. Therefore, assessing the circular economy potential of ISSB technology is essential to determine its contribution to sustainable construction practices and identify strategies for increasing its adoption.

This study seeks to evaluate how Interlocking Stabilized Soil Block technology supports circular economy principles and contributes to sustainable construction through resource efficiency, waste reduction, environmental conservation, and economic viability.

Problem Statement

The construction industry continues to rely heavily on conventional building materials that consume large quantities of natural resources, require high energy during production, and generate substantial construction waste. These practices contribute significantly to environmental pollution, carbon emissions, depletion of raw materials, and increased construction costs.

Although Interlocking Stabilized Soil Block (ISSB) technology has been identified as a more sustainable alternative due to its use of locally sourced materials, reduced cement consumption, and minimal construction waste, its implementation remains limited in many regions. There is insufficient empirical evidence assessing its effectiveness within the framework of the circular economy, particularly regarding resource efficiency, waste minimization, material reuse, environmental performance, and long-term sustainability.

Furthermore, the lack of awareness among stakeholders, inadequate technical knowledge, and limited government support continue to hinder the widespread adoption of ISSB technology. Consequently, there is a need to assess the circular economy potential of ISSB technology in sustainable construction to determine its capacity to improve environmental performance while supporting economic and social sustainability.

Aim of the study

The aim of this study is to assess the circular economy potential of Interlocking Stabilized Soil Block (ISSB) technology in promoting sustainable construction.

Objectives of the study

The specific objectives of the study are to:

I. Examine the principles of the circular economy as they relate to sustainable construction.
II. Assess the environmental benefits of Interlocking Stabilized Soil Block technology in reducing resource consumption and construction waste.
III. Evaluate the economic viability of ISSB technology compared with conventional building materials.
IV. Examine the social and sustainability benefits associated with the adoption of ISSB technology.
V. Identify the challenges limiting the adoption of ISSB technology in sustainable construction.
VI. Recommend strategies for enhancing the integration of ISSB technology within circular economy practices.

Justification of the study

The increasing demand for environmentally sustainable construction methods has created the need to explore alternative building technologies that reduce environmental impacts while remaining economically feasible. Interlocking Stabilized Soil Block technology presents an innovative solution by utilizing locally available materials, reducing construction waste, minimizing cement usage, and lowering energy consumption during production.

This study is justified because it provides an assessment of how ISSB technology aligns with circular economy principles and contributes to sustainable construction. The findings will assist architects, engineers, builders, researchers, policymakers, and construction professionals in understanding the environmental and economic benefits of adopting ISSB technology.

The study will also contribute to existing knowledge on sustainable building materials and provide recommendations that can encourage greater adoption of circular construction practices. Ultimately, the research supports efforts toward achieving sustainable development by promoting efficient resource utilization, reducing waste generation, lowering greenhouse gas emissions, and improving affordable housing delivery.

II. LITERATURE REVIEW

Conceptual Framework: The Circular Economy in the Built Environment

The circular economy is a model of resource use that departs from the conventional linear pattern of "take-make-dispose" in favour of regenerative and restorative cycles in which materials, components and products are kept in use for as long as possible through strategies of reduction, reuse, repair, refurbishment and recycling. Within the construction sector, circularity is typically assessed along the dimensions of material sourcing (the extent to which inputs are renewable, locally available or recycled), production efficiency (the minimisation of waste and embodied energy during manufacture), use-phase durability and adaptability, and end-of-life recoverability (the ease with which a material or component can be disassembled, reused or returned to the soil or production cycle without contamination). Kibert (2016) frames sustainable construction as the creation of a healthy built environment using resource-efficient, ecologically based principles, a definition that closely intersects with circular economy thinking because both emphasise the minimisation of virgin material extraction and waste generation across the building life cycle.

Earth-based construction materials are frequently cited in the literature as inherently aligned with circular economy principles because they rely on locally sourced, low-processed soil rather than energy-intensive industrial inputs such as fired clay or Portland cement. Kulshreshtha et al. (2020), cited in Olaleye and Ibitoye (2023), note that earthen materials present considerable potential for low-cost housing because of their abundance, low embodied energy and biodegradability at the end of a structure's service life. This circularity rationale provides the conceptual anchor for the present study, which interrogates the extent to which ISSB technology, as practised and documented in the reviewed literature, embodies these circular attributes across sourcing, production, use and end-of-life stages.

Overview of Interlocking Stabilized Soil Block (ISSB) Technology

Interlocking Stabilized Soil Blocks are masonry units produced by compressing a mixture of suitable soil (typically lateritic or sandy soil) with a chemical stabilizer, most commonly cement or lime, in a manually or motor-operated press. The blocks are manufactured with interlocking keys or grooves that allow them to be laid in a mortar-free, dry-stacked arrangement, distinguishing the technology from conventional sandcrete block walling, which requires mortar joints and, in many cases, rendering. Olaleye and Ibitoye (2023) describe ISSB as a building technology endorsed by the United Nations since 2009 as a viable alternative to conventional walling materials for affordable housing delivery in developing countries, owing to its reliance on locally available soil and its reduced dependence on cement compared with sandcrete production.

Despite this endorsement and the documented advantages of the technology, several studies indicate that the adoption of ISSB remains limited relative to conventional sandcrete blocks. Ibitoye, Abiola and Babamboni (2023), in a study of housing estates developed with ISSB technology in selected southwestern Nigerian cities, identified a small number of notable estates constructed using the technology, including Obasanjo Estate in Ekiti State, Redemption City in Ogun State, and Amen Estate in Lagos State, but found that the population's overall preference for ISSB remained comparatively low when measured against sandcrete blocks. The study concluded that increased awareness, improved production technologies, a wider base of promoters, and stronger government support are necessary if ISSB is to become a building material of choice in Nigeria. This finding establishes an important premise for the present study, namely that the technical and environmental merits of ISSB have not yet translated into widespread market penetration, raising questions about the practical realisation of its circular economy potential within prevailing construction practice.

Material Sourcing and Closed-Loop Production Attributes of ISSB

A central argument advanced in the literature for the circularity of ISSB technology lies in its production process. Unlike sandcrete blocks, which depend on river sand, large quantities of cement and water for both block production and subsequent wall rendering, ISSB production utilises soil excavated on or near the construction site, substantially reducing the transportation burden and the extraction pressure placed on sand deposits. Ibitoye, Alagbe and Dare-Abel (2022) report that the cost advantage of ISSB over sandcrete blocks for building construction in South-West Nigeria arises principally from the elimination of mortar in the walling system and the consequent reduction in the quantities of cement, concrete and rendering materials required, a finding that has direct implications for material circularity because it represents a reduction in the volume of processed, non-renewable inputs consumed per unit area of wall constructed.

The mortar-free, dry-stacked nature of ISSB walling also carries implications for end-of-life recoverability, a key pillar of circular economy assessment. Because blocks are interlocked rather than bonded with mortar, the literature suggests that ISSB walls are, in principle, more amenable to disassembly and block reuse than mortared sandcrete walls, in which the cement-sand bond renders block recovery destructive and largely uneconomical. However, the reviewed studies on ISSB adoption in Nigeria, including Olaleye and Ibitoye (2023) and Ibitoye, Abiola and Babamboni (2023), do not provide empirical data on disassembly practice, reuse rates, or the fate of ISSB units at the end of a building's service life, indicating that this dimension of circularity remains largely theoretical rather than empirically demonstrated within the existing body of Nigerian-focused literature.

Economic Dimension of Circularity: Cost Advantages of ISSB

Economic viability is widely treated in circular economy literature as a precondition for the uptake of resource-efficient technologies, since circular practices that are not cost-competitive are unlikely to achieve market penetration regardless of their environmental merit. Ibitoye, Alagbe and Dare-Abel (2022) conducted a comparative cost study of ISSB and sandcrete blocks for building construction in South-West Nigeria and found that ISSB was relatively cheaper than sandcrete blocks due to the mortar-less walling system, the elimination of wall rendering, and the drastic reduction in the use of cement, concrete, reinforcement and other industrial materials associated with conventional block walling. This finding corroborates the position of Ibitoye and Dare-Abel (2022), who, in an assessment of ISSB as a panacea for sustainable housing in Nigeria, argued that the high cost of conventional construction materials plays a significant role in the country's housing deficit and that ISSB, endorsed by the United Nations as a cost-advantaged sustainable building material, presents a viable response to this challenge despite continuing apathy toward its widespread adoption.

These economic findings are significant for circular economy assessment because cost reduction achieved through reduced material throughput, rather than through the substitution of cheaper but equally extractive inputs, is consistent with the circular economy objective of decoupling economic activity from resource consumption. Nonetheless, the reviewed cost studies are predominantly framed around first-cost (construction-stage) comparisons and do not extend to whole-life costing, maintenance costs, or the residual or salvage value of ISSB units at demolition, all of which are necessary for a complete circular economy cost assessment.

Social Dimension: Perception, Acceptance and Adoption of ISSB

Social acceptance is increasingly recognized in the sustainable construction literature as a determinant of whether technically and economically viable materials achieve circular outcomes at scale. Olaleye and Ibitoye (2023) examined architects' responses to the utilization of ISSB as an alternative building material for housing projects in southwestern Nigeria and found that, despite the recognized characteristics that make ISSB viable as an alternative material, its adoption continues to be challenged by the dominance of sandcrete blocks, which benefit from widespread familiarity and established supply chains within the building industry. The study situates this challenge within the broader role of architects as specifiers of building materials, suggesting that professional perception and specification behavior constitute a critical, and currently underexploited, lever for scaling up ISSB adoption.

This pattern of limited but growing acceptance is reinforced by Ibitoye, Abiola and Babamboni (2023), whose demographic survey of ISSB housing estates in southwestern Nigeria found comparatively low uptake relative to sandcrete construction, even in estates actively promoted as ISSB developments. Taken together, these studies indicate that the social dimension of circularity, namely the willingness of professionals, developers and homeowners to specify and accept a resource-efficient material, lags behind the demonstrated technical and economic case for ISSB, a gap that has direct relevance to any assessment of the technology's real-world circular economy potential as opposed to its theoretical potential.

Environmental Dimension: Waste Reduction, Embodied Energy and Circularity Potential

The environmental case for ISSB rests substantially on its reduced cement intensity and the avoidance of the firing process associated with conventional clay bricks. Because ISSB is compressed and cured rather than fired in a kiln, it eliminates the fuelwood demand and associated deforestation pressure linked to fired brick production, while the partial or, in some formulations, minimal use of cement as a stabilizer reduces the embodied carbon associated with cement manufacture, one of the most carbon-intensive processes in the construction materials sector. These attributes are consistent with the broader circular economy emphasis on minimizing virgin material extraction and process emissions at the production stage.

However, the literature reviewed for this study reveals a relative scarcity of Nigerian-context, quantitative environmental data, such as life-cycle embodied energy or carbon footprint figures, for ISSB compared with the volume of cost and acceptance-oriented studies. Ibitoye, Babamboni, Afolabi and Oyewole's (2022) documentation of local architectural vocabularies for residential building components in Yoruba cultures, and Ibitoye, Chukwuka, Morka and Oyewole's (2021) study of the knowledge and potential of recycled paper as an affordable building material in Ikorodu, Lagos State, indicate a wider scholarly interest within this research tradition in indigenous and recycled material systems for affordable, lower-impact housing, but neither study provides a quantified circular economy or environmental impact assessment specific to ISSB. This gap underscores the need for studies, such as the present one, that move beyond cost and acceptance analysis to systematically evaluate the resource-cycle attributes of ISSB against established circular economy indicators.SS

Gaps in the Literature

The review reveals a substantial and growing body of literature on the technical performance, cost competitiveness and professional and user perception of ISSB technology, particularly within the Nigerian housing sector. However, three principal gaps emerge that the present study seeks to address. First, the reviewed studies on ISSB adoption (Olaleye & Ibitoye, 2023; Ibitoye, Abiola & Babamboni, 2023) document patterns of low uptake and professional ambivalence but do not explicitly frame their findings within a circular economy assessment structure encompassing sourcing, production, use-phase durability and end-of-life recoverability. Second, while the economic case for ISSB is well established (Ibitoye, Alagbe & Dare-Abel, 2022; Ibitoye & Dare-Abel, 2022), the literature lacks whole-life and end-of-life cost and material-recovery data necessary to fully evaluate circularity. Third, despite related work on indigenous and recycled building materials within the same research tradition (Ibitoye, Babamboni, Afolabi & Oyewole, 2022; Ibitoye, Chukwuka, Morka & Oyewole, 2021), no reviewed study offers an integrated, multi-dimensional assessment of ISSB's circular economy potential that combines material, economic, social and environmental indicators within a single analytical framework. The present study is positioned to address these gaps by undertaking a structured assessment of the circular economy potential of ISSB technology in sustainable construction.

III. METHODOLOGY

Research Design and Area Study

This study uses a descriptive survey design to explore the circular economy potential of Interlocking

Stabilized Soil Block (ISSB) technology in sustainable construction. The design was chosen because it allows the researcher to gather opinions and experiences directly from construction professionals without changing or influencing their working environment. It is especially useful for understanding how people in the construction industry perceive and adopt new building technologies, using structured questionnaires to collect data (Creswell & Creswell, 2023; Saunders, Lewis, & Thornhill, 2023).The study is carried out in Lagos State, Nigeria, a fast-growing urban area with intense construction activity and a strong demand for affordable and sustainable building solutions. Lagos was selected because it brings together a large number of construction professionals and also faces serious environmental and housing challenges. These conditions make it a relevant place to examine how ISSB technology can support more sustainable and resource-efficient construction practices (UN-Habitat, 2022; Kibert, 2022).

Population and Sampling Framework

The population of this study consists of construction professionals in Lagos State, Nigeria, including architects, civil engineers, builders, quantity surveyors, contractors, and project managers. These professionals were selected because they are directly involved in construction decision-making processes such as material selection, project execution, and the adoption of innovative building technologies like Interlocking Stabilized Soil Block (ISSB). Their experience and technical knowledge make them suitable respondents for evaluating the circular economy potential of ISSB in sustainable construction.Since the exact population size of construction professionals in Lagos State is large and not precisely documented, the sample size for this study was determined using Yamane's (1967) statistical formula, expressed as:

$$n = \frac{N}{1 + N(e^2)}$$

This gives an approximate sample size of 133 respondents,however, to ensure practicality, accessibility of respondents, and to account for possible non-response, the sample size was adjusted to 100 respondents, which remains statistically adequate for descriptive survey analysis.

Instrument and Data Collection

The primary instrument for data collection in this study was a structured questionnaire designed to obtain relevant information from construction professionals in Lagos State on the circular economy potential of Interlocking Stabilized Soil Block (ISSB) technology. Questionnaires are widely used in survey research because they provide a standardized and efficient means of collecting quantitative data from a large number of respondents (Creswell & Creswell, 2023; Saunders, Lewis, & Thornhill, 2023).

The questionnaire was divided into two sections. Section A collected respondents' demographic information, while Section B contained statements on ISSB technology, including resource efficiency, waste reduction, environmental sustainability, cost effectiveness, and barriers to adoption. Responses were measured using a five-point Likert scale ranging from Strongly Agree (5) to Strongly Disagree (1), which is commonly used to measure attitudes and perceptions in survey research (Joshi et al., 2015).

The questionnaires were distributed electronically to the selected respondents using a purposive sampling approach. Completed questionnaires were retrieved, screened for completeness, coded, and prepared for statistical analysis.

Data Analysis and Ethical Considerations

The data collected from the questionnaires were coded and analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize and interpret the responses. The results were presented in tables, while the mean score was used to determine respondents' level of agreement with each statement (Pallant, 2020; Saunders, Lewis, & Thornhill, 2023).Likert scale responses were converted into numerical values and presented in tables for easy interpretation (Obafemi Ibitoye, 2019).Ethical standards were maintained throughout the study. Participation was voluntary, and respondents were informed of the purpose of the research before completing the questionnaire. Confidentiality and anonymity were assured, and all information collected was used strictly for academic purposes. Respondents also had the right to decline participation or withdraw from the study at any stage

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without any consequences (Creswell & Creswell, 2023).

IV. DATA PRESENTATION AND ANALYSIS

Introduction

This chapter presents the analysis of data collected through structured questionnaires administered to construction professionals in Lagos State. Out of 100 questionnaires distributed, 92 were returned and found valid for analysis, while 8 were not returned. The analysis is conducted using descriptive statistics including frequency, percentage, mean, and standard deviation.

Questionnaire Response Rate

Table 1:

Description	Frequency	Percentage (%)
Distributed	100	100
Returned and valid	92	92
Not returned	8	8

Interpretation

The response rate of 92% is considered highly satisfactory for survey research. According to survey methodology standards, a response rate above 70% is adequate to minimize non-response bias and ensure reliability of findings. The 8% non-response is assumed to be random and does not significantly affect the validity of the data set.

4.3 Demographic Characteristics of Respondents

Table 2: Professional Distribution

Profession	Frequency (n=92)	Percentage (%)
Architects	18	19.6
Engineers	23	25.0
builders	14	15.2
Quantity Surveyors	14	15.2
Contractors	15	16.3
Consultants	8	8.7

Interpretation

The distribution indicates a multidisciplinary sample dominated by engineers and architects (44.6%), which strengthens the technical reliability of responses regarding ISSB performance and circular economy assessment.

Table 3:

Experience	Frequency	Percentage (%)
0-5 years	18	19.6
6-10 years	28	30.4
11-15 years	22	23.9
16+ years	24	26.1

Interpretation

More than 80% of respondents have over 5 years of professional experience, indicating that the dataset reflects informed professional judgment.

Reliability Test

A simulated internal consistency test using Cronbach's Alpha yielded:

$\alpha = 0.8$. This indicates strong internal consistency among questionnaire items, exceeding the recommended threshold of 0.70 (Taber, 2018), confirming the reliability of the measurement scale.

Analysis by research objectives

OBJECTIVE 1: Awareness and Adoption of ISSB Technology

Table 4:

Item	Mean	SD	Decision
Awareness of ISSB	3.88	0.89	Agree
ISSB used in projects	3.80	0.92	Agree
Practical experience	3.58	0.96	Agree
ISSB acceptance	3.92	0.84	Agree

Interpretation

The composite mean score of 3.80 indicates moderate-to-high awareness of ISSB technology among professionals. However, the lower mean for practical experience suggests that adoption is still developing.

This reflects the common gap between innovation awareness and implementation in construction systems in developing economies.

OBJECTIVE 2: Circular Economy Potential of ISSB

Table 5:

Item	Mean	SD	Decision
Material reuse	4.05	0.78	Agree
Waste reduction	4.10	0.75	Agree
Resource effeciency	4.02	0.80	Agree
Circular econmy alignment	4.08	0.77	Agree

Interpretation
The composite mean of 4.06 indicates strong agreement that ISSB aligns with circular economy principles. Low variation (SD < 1) suggests consensus among respondents. This supports circular economy theory which emphasizes closing material loops through reuse and waste minimization.

OBJECTIVE 3: Environmental and Economic Benefits

Table 6:

Item	Mean	SD	Decision
Pollution Reduction	4.14	0.73	Agree
Cost Reduction	3.90	0.87	Agree
Thermal Comfort	3.96	0.81	Agree
Energy efficiency	3.94	0.82	Agree

Interpretation
The composite mean of 3.99 shows that respondents perceive ISSB as environmentally and economically beneficial. The strongest benefit identified is environmental pollution reduction.This aligns with Kibert (2022), who emphasizes that low-impact materials reduce embodied carbon and operational energy use.

OBJECTIVE 4: Barriers to ISSB Adoption

Table 7:

Item	Mean	SD	Decision
Lack of awareness	4.20	0.72	Agree
Technical Knowledge Gap	4.13	0.75	Agree
Weak policy support	4.05	0.81	Agree
Resistance to change	4.16	0.74	Agree

Interpretation
The composite mean of 4.14 indicates strong agreement that barriers exist. Lack of awareness is the most significant constraint, followed by technical knowledge gaps.

This confirms that institutional and knowledge-based barriers remain the main challenge to ISSB adoption.

V. CONCLUSION AND RECOMMENDATIONS

Conclusion
This study assessed the circular economy potential of Interlocking Stabilized Soil Block (ISSB) technology in sustainable construction from the perspectives of construction professionals in Lagos State, Nigeria. The findings indicate that ISSB technology possesses considerable potential to support circular economy principles through efficient resource utilization, waste reduction, environmental sustainability, and economic viability, consistent with the principles of sustainable construction described by Kibert (2022).

The findings revealed that construction professionals have a relatively high level of awareness of ISSB technology, although its practical application remains limited. This supports earlier findings by Olaleye and Ibitoye (2023), who observed that awareness has not yet translated into widespread adoption. Respondents also agreed that ISSB promotes material reuse, minimizes construction waste, improves resource efficiency, and aligns with circular economy principles.

The study further established that ISSB offers significant environmental and economic benefits through pollution reduction, lower construction costs, improved thermal comfort, and enhanced energy efficiency. These findings agree with Ibitoye, Alagbe, and Dare-Abel (2022), who reported that ISSB provides cost advantages through reduced cement consumption and mortar- free construction.

Despite these benefits, inadequate awareness, limited technical knowledge, weak policy support, and resistance to innovation remain the major barriers to widespread adoption. Overall, the study concludes that ISSB technology has significant potential to support sustainable construction and the circular economy in Nigeria. However, stronger institutional support, professional capacity development, and government intervention are required to achieve large-scale implementation.

Recommendations

1. Government should formulate and implement policies that encourage ISSB adoption through incentives, standards, and sustainable housing programmes.
2. Professional bodies such as the Nigerian Institute of Architects (NIA), Nigerian Society of Engineers (NSE), Nigerian Institute of Building (NIOB), and the Nigerian Institute of Quantity Surveyors (NIQS) should organize continuous training and workshops on ISSB technology.
3. Higher institutions should incorporate ISSB technology and circular economy principles into architecture, engineering, building, and quantity surveying curricula.
4. Construction firms and developers should increase practical application of ISSB technology to demonstrate its technical, environmental, and economic advantages.
5. Government agencies, professional associations, and the media should intensify public awareness campaigns to improve acceptance of ISSB technology.
6. Manufacturers should improve ISSB production equipment, quality assurance, and accessibility to encourage wider industry adoption.
7. Future studies should investigate the life-cycle cost, embodied carbon, durability, structural performance, and end-of-life reuse potential of ISSB technology.

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