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Financing Green Supply Chain Management: Key Components for Building Construction Project Delivery in South-East Nigeria

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Abstract- The buildings and construction sector accounted for approximately 37% of global CO_2 emissions in 2023, creating an urgent need for Green Supply Chain Management (GSCM) in construction. This study develops a GSCM framework for building construction project delivery in South-East Nigeria by identifying and ranking key GSCM components. A structured questionnaire was administered to 890 construction professionals across five states, with 844 valid responses analysed using the Relative Importance Index (RII). The findings reveal five GSCM dimensions: environmental, economic, social/human, operational/technological, and regulatory/policy/strategic. The highest-ranked components were Resource Conservation (ENV, RII = 0.791), Cost-effectiveness of Green Materials (ECO, RII = 0.791), Public Awareness (SOC, RII = 0.724), Green Innovation (OP, RII = 0.796), and International Standards Compliance (RP, RII = 0.746). The study concludes that GSCM in building construction is multidimensional, requiring coordinated attention to environmental, economic, social, operational, and regulatory factors. The framework provides a context-specific evidence base for policymakers, construction professionals, and stakeholders seeking to strengthen sustainable supply-chain practices in South-East Nigeria.

Keywords: Green Supply Chain Management, Building Construction, Project Delivery, Relative Importance Index, Sustainability, Nigeria

I. INTRODUCTION

The construction industry is fundamental to economic development because it provides buildings, infrastructure and employment while supporting urbanisation and industrial activity. At the same time, construction is associated with substantial consumption of energy and materials and significant environmental pressures. The buildings and construction sector accounted for approximately 37% of global CO_2 emissions in 2023, while the production of construction materials such as cement and steel remains a major source of embodied emissions (United Nations Environment Programme [UNEP] & Global Alliance for Buildings and Construction [GlobalABC], 2025). These environmental pressures have increased the need to move beyond conventional construction management approaches that primarily emphasize cost, time and quality towards approaches that integrate environmental considerations throughout the construction supply chain.

Green Supply Chain Management (GSCM) provides one such approach. GSCM extends conventional supply chain management by incorporating environmental considerations into activities including procurement, material selection, production, transportation, construction processes, waste management and end-of-life activities. In construction, its importance derives partly from the fragmented nature of project supply chains, where designers, clients, contractors, suppliers, manufacturers and waste-management actors influence environmental outcomes at different stages of the project lifecycle. Badi and Murtagh (2019), through a systematic review of the construction GSCM literature, found that GSCM provides a systemic approach for integrating environmental objectives with supply-chain collaboration, process integration and relationship management. Similarly, Balasubramanian and Shukla (2017) developed and empirically examined a multidimensional GSCM framework for the construction sector and reported that implementation of green practices can contribute positively to environmental, economic and organisational performance.

The relevance of GSCM is particularly important in developing-country construction environments, where resource constraints, institutional weaknesses and fragmented supply-chain relationships can complicate the adoption of sustainable practices. Ahmed et al. (2020), examining construction supply chains across developing countries, identified barriers associated with stakeholder involvement and support, while also highlighting opportunities arising from environmentally oriented practices such as green procurement, green design, green distribution and end-of-life management. These findings indicate that successful implementation of GSCM requires more than the adoption of isolated environmental practices; it requires coordination among the actors and processes that collectively constitute the construction supply chain.

The Nigerian construction industry presents a particularly important context for examining these issues. Previous research has identified the need to improve the environmental management of construction activities in Nigeria. Ojo, Mbhowa and Akinlabi (2014) examined GSCM in the construction industries of Nigeria and South Africa and identified the growing relevance of green supply-chain practices to construction sustainability. Their related investigation of Nigerian construction firms identified factors including inadequate awareness, limited knowledge, weak management commitment and insufficient government or legal enforcement as barriers to GSCM implementation. Although these studies provide an important foundation, there remains a need for research that translates the broader GSCM concept into a structured framework specifically applicable to building construction project delivery in Nigeria.

Construction waste provides another indication of the sustainability challenge. Aboginije, Aigbavboa and Thwala (2021), in an assessment of construction and demolition waste management in Nigerian construction projects, examined waste-management practices among construction professionals and highlighted the importance of improving waste-management strategies. More recently, Unegbu and Yawas (2024) identified inadequate infrastructure and weak regulatory enforcement among the challenges affecting construction and demolition waste management in Nigeria. Such findings reinforce the importance of considering environmental performance across the construction supply chain rather than treating waste management as an isolated activity.

Despite increasing international attention to GSCM, important contextual and implementation gaps remain. The systematic review by Badi and Murtagh (2019) identified the need for end-to-end approaches that reflect the distinctive characteristics of construction and translate GSCM research into practical guidance. In the Nigerian context, the available literature has examined issues such as green supply-chain practices, barriers to adoption and construction-waste management, but there remains scope for an integrated framework that identifies the key components required for sustainable building construction project delivery, particularly at the regional level.

South-East Nigeria provides a relevant setting for such an investigation. The region comprises Abia, Anambra, Ebonyi, Enugu and Imo States and has experienced continuing urban development and construction activity. Building projects in the region involve interconnected decisions concerning material sourcing, procurement, transportation, construction operations, energy use and waste management. Where these activities are managed independently, opportunities for reducing environmental impacts and improving resource efficiency may be missed. A structured GSCM framework could therefore provide a basis for coordinating environmental considerations across these activities and for clarifying the roles of project stakeholders.

II. LITERATURE REVIEW

Green Supply Chain Management (GSCM) refers to the integration of environmental considerations into supply-chain activities, including sourcing, procurement, production, logistics, product recovery and waste management. The concept extends conventional supply-chain management by incorporating environmental objectives into decisions concerning materials, processes, transportation and end-of-life management (Srivastava, 2007). From a broader sustainability perspective, supply-chain management may also integrate environmental, social and economic considerations in order to achieve long-term organizational and supply-chain viability (Carter & Rogers, 2008).

The relevance of GSCM to construction is particularly significant because construction projects involve extensive flows of materials, equipment, energy, information and waste across multiple organizations. Unlike conventional manufacturing systems, construction supply chains are often project-based and involve temporary relationships among clients, designers, contractors, subcontractors, suppliers and logistics providers. Consequently, environmental performance depends not only on the actions of individual organizations but also on how environmental considerations are coordinated across the project supply chain. Balasubramanian and Shukla (2017) argue that the green outcome of a construction project is the cumulative result of environmental efforts undertaken at different supply-chain stages, from initial design to end-of-life activities.

GSCM therefore provides a framework for incorporating environmental considerations throughout the project lifecycle. Its practices may include green procurement, environmentally conscious design, supplier environmental assessment, cleaner production, sustainable transportation, waste minimization, reverse logistics and material recovery (Srivastava, 2007). These practices can contribute to improved environmental performance while also supporting operational efficiency and resource productivity.

The conceptual foundation of GSCM is also consistent with the natural-resource-based view of the firm. Hart (1995) identifies pollution prevention, product stewardship and sustainable development as strategic approaches through which organizations can respond to environmental constraints and develop capabilities associated with sustainable competitive advantage. Within construction, these principles can be translated into pollution prevention, responsible material selection, resource conservation, lifecycle thinking and recovery of construction materials.

Overview of Green Supply Chain Practice in Nigeria

The application of GSCM in Nigeria must be understood within the country's institutional, economic and infrastructural context. Construction activities generate environmental pressures through material extraction, transportation, energy consumption, construction processes and waste generation. Consequently, the integration of environmental considerations into construction procurement and project delivery is relevant to both environmental management and resource efficiency.

GSCM practices generally encompass environmentally responsible purchasing, eco-design, cleaner production, green logistics and reverse logistics (Srivastava, 2007). Empirical research has also demonstrated that GSCM can be operationalized through identifiable organizational practices and measured using structured indicators (Zhu et al., 2008). These practices provide a useful conceptual basis for assessing GSCM implementation in construction.

In Nigeria, environmental management within the construction sector is supported by formal regulatory requirements. The National Environmental (Construction Sector) Regulations, S.I. No. 19 of 2011, were established to prevent and minimize pollution arising from construction, decommissioning and demolition activities. The regulations address issues including environmental planning, waste management, dust and fugitive emissions, noise, stormwater and hazardous substances. They also provide for site waste-management requirements for new construction projects (Federal Republic of Nigeria, 2011).

The existence of such regulations demonstrates that environmental considerations are formally recognized within Nigeria's construction sector. However, the existence of regulation does not necessarily establish the level of implementation by individual construction organizations. The effectiveness of GSCM therefore depends on the interaction between regulatory requirements, organizational capabilities, supply-chain relationships, technological capacity, financial resources and stakeholder expectations.

Green construction practices may also involve the selection of environmentally preferable materials, reduction of material waste, energy-efficient construction processes, lifecycle assessment and the recovery or reuse of materials. Life-cycle assessment provides an established methodological approach for evaluating environmental impacts associated with buildings and building materials over different stages of their life cycle (Cabeza et al., 2014; Zabalza Bribián et al., 2011).

Accordingly, GSCM in the Nigerian construction context can be conceptualized as the coordinated integration of environmental considerations into the sourcing, design, procurement, transportation, construction, operation, maintenance and end-of-life stages of building projects. This conceptualization provides a basis for examining the environmental, economic, social, operational, technological and regulatory factors that influence green supply-chain implementation.

Key Components of Green Supply Chain Management for Building Construction Project Delivery

GSCM in building construction extends beyond individual environmental practices. It involves the integration of environmental objectives into decisions and relationships across the construction project lifecycle. Balasubramanian and Shukla (2017) emphasize that construction-sector GSCM involves activities extending from design through procurement, construction and end-of-life stages.

The principal components relevant to building construction include the following.

Green Design and Eco-design.
Environmental considerations can be incorporated during the design stage through material selection, energy efficiency, durability, adaptability, resource efficiency and consideration of end-of-life recovery. Life-cycle assessment provides a methodological basis for comparing environmental impacts associated with building materials and design alternatives (Zabalza Bribián et al., 2011; Cabeza et al., 2014).

Green Procurement.
Green procurement involves incorporating environmental criteria into purchasing and supplier-selection decisions. Such criteria may include material composition, energy requirements, recyclability, durability, environmental certifications and supplier environmental performance. GSCM literature identifies purchasing and supplier-management practices as important elements of environmentally responsible supply chains (Srivastava, 2007; Zhu et al., 2008).

Green Materials Management.
Materials constitute a major component of construction supply chains. Their extraction, processing, transportation and use have environmental implications. Life-cycle assessment research demonstrates that building materials differ considerably in energy and environmental impacts, making material selection an important element of sustainable construction (Zabalza Bribián et al., 2011).

Green Construction Processes
Green construction processes seek to reduce unnecessary consumption of energy and materials, prevent pollution and minimize waste. These objectives are closely associated with pollution prevention and resource-efficiency principles (Hart, 1995).

Green Logistics
Transportation contributes to environmental impacts through fuel consumption and emissions. Green logistics therefore seeks to improve transportation efficiency, reduce unnecessary movements and integrate environmental considerations into logistics decisions. Within construction, logistics decisions

concerning material delivery, storage and handling can affect both environmental and operational performance.

Waste Management and Reverse Logistics
Construction and demolition waste represents an important environmental challenge. Waste management research identifies waste minimization, reuse, recycling and recovery as important approaches for improving construction resource efficiency (Lu & Yuan, 2011; Formoso et al., 2002). Reverse logistics extends this approach by creating systems through which materials and products can flow back for reuse, recycling or recovery.

Lifecycle Management
Lifecycle thinking requires environmental impacts to be considered beyond the construction stage. Life-cycle assessment of buildings examines environmental consequences across different stages, thereby providing a basis for evaluating design and material alternatives (Cabeza et al., 2014).

On the basis of the reviewed literature, the present study groups the measurable GSCM factors into five broad dimensions: environmental factors; economic factors; social and human factors; operational and technological factors; and regulatory, policy and strategic factors.

Table 2.1: Proposed Indicators of GSCM for Building Construction Project Delivery

Dimension	Code	Indicator
Environmental	ENV 1	Pollution reduction
Environmental	ENV 2	Resource conservation
Environmental	ENV 3	Waste management
Environmental	ENV 4	Carbon-emission control
Environmental	ENV 5	Biodiversity and ecosystem protection
Environmental	ENV 6	Eco-design
Economic	ECO 1	Cost of green materials
Economic	ECO 2	Return on green investment
Economic	ECO 3	Energy efficiency
Economic	ECO 4	Access to green financing
Economic	ECO 5	Market competitiveness
Economic	ECO 6	Operational cost savings
Social/Human	SOC 1	Public awareness
Social/Human	SOC 2	Corporate social responsibility
Social/Human	SOC 3	Labour practices
Social/Human	SOC 4	Green-skill development
Social/Human	SOC 5	Stakeholder engagement
Social/Human	SOC 6	Cultural attitudes
Operational/Technological	OP1	Green procurement
Operational/Technological	OP2	Sustainable transportation
Operational/Technological	OP3	Reverse logistics
Operational/Technological	OP4	Supplier collaboration
Operational/Technological	OP5	Life-cycle assessment
Operational/Technological	OP6	Green innovation
Regulatory/Policy/Strategic	RP1	Environmental regulation
Regulatory/Policy/Strategic	RP2	Green certification
Regulatory/Policy/Strategic	RP3	Government incentives
Regulatory/Policy/Strategic	RP4	Strategic leadership

Regulatory/Policy/Strategic	RP5	Sustainability reporting
Regulatory/Policy/Strategic	RP6	International standards compliance

The proposed indicators should be understood as operational variables developed from the literature rather than as universally agreed dimensions of GSCM. This distinction is important because previous research demonstrates considerable variation in the metrics used to assess green and sustainable supply-chain performance. Ahi and Searcy (2015), for example, identified thousands of metrics across the literature and found substantial variation in how environmental and sustainability performance was measured. Consequently, the indicators adopted in this study are contextualized to building construction project delivery in Southeast Nigeria.

Environmental Factors Affecting Green Supply Chain Management

Environmental factors constitute an important dimension of GSCM because they define the ecological impacts that organizations seek to reduce through supply-chain decisions. The natural-resource-based view identifies pollution prevention, product stewardship and sustainable development as strategic responses to environmental constraints (Hart, 1995). GSCM extends these principles across supply-chain activities by integrating environmental considerations into purchasing, production, logistics and recovery processes (Srivastava, 2007).

Within construction, environmental concerns include pollution, resource consumption, construction waste, greenhouse-gas emissions, land disturbance and ecological impacts. These concerns can arise at different points in the project lifecycle, including raw-material extraction, manufacturing, transportation, construction, building operation and demolition.

Based on the literature and the requirements of the present study, six environmental factors are adopted: pollution reduction, resource conservation, waste management, carbon-emission control, biodiversity and ecosystem protection, and eco-design.

Pollution Reduction (ENV1)

Pollution reduction is a fundamental element of environmentally responsible supply-chain management. Pollution may occur through emissions, wastewater, construction-site runoff, hazardous materials, dust and improper waste disposal. Hart (1995) conceptualizes pollution prevention as a strategic environmental capability, emphasizing prevention at source rather than reliance solely on corrective measures.

Construction projects can generate pollution through the use of fuels and machinery, material processing, transportation, site activities and waste disposal. Pollution-control measures can therefore be integrated into procurement, logistics, construction methods and waste-management systems.

The Nigerian regulatory framework provides a formal basis for pollution prevention in construction. The National Environmental (Construction Sector) Regulations, 2011 specifically seek to prevent and minimize pollution arising from construction, decommissioning and demolition activities. The regulations address dust and fugitive emissions, noise, stormwater, hazardous substances and waste-management practices (Federal Republic of Nigeria, 2011).

Within GSCM, pollution reduction can therefore be operationalized through practices such as:selecting materials and suppliers with improved environmental performance, reducing unnecessary transportation and fuel consumption, controlling dust and site emissions, managing hazardous substances appropriately, preventing contaminated stormwater discharge, segregating and properly managing construction waste; and applying cleaner construction processes where technically and economically feasible.

Pollution reduction is consequently treated in this study as the extent to which construction organizations incorporate measures designed to prevent or minimize environmental pollution throughout the construction supply chain.

Resource Conservation (ENV2)

Resource conservation concerns the efficient use of materials, energy, water and other resources throughout the project lifecycle. Construction is materially intensive, and decisions made during design and procurement can influence the quantities and types of resources consumed throughout a building's life.

Life-cycle assessment research demonstrates that construction materials differ in their energy requirements and environmental impacts. Zabalza Bribián et al. (2011), for example, compared building materials using life-cycle assessment and demonstrated the relevance of embodied energy and environmental impacts to material-selection decisions. Cabeza et al. (2014) similarly reviewed life-cycle assessment and life-cycle energy analysis in buildings and highlighted the importance of evaluating environmental impacts across the building lifecycle.

Resource conservation within GSCM may therefore involve:efficient material planning and procurement, reduction of unnecessary material consumption, selection of materials with lower environmental impacts, reuse and recycling of construction materials, efficient energy use, efficient water use, reduction of material losses during transportation and storage; and consideration of resource recovery at the end of a building's useful life.

Resource conservation is closely connected to construction waste management because materials that are unnecessarily discarded represent both environmental losses and economic costs. Formoso et al. (2002) demonstrate that material waste is an important construction-management problem and that identifying the causes of waste can support preventive action.

For this study, resource conservation therefore refers to practices through which construction organizations seek to reduce unnecessary consumption of materials, energy and water while improving the efficiency of resource utilization.

Waste Management (ENV3)

Construction and demolition waste management is a major component of sustainable construction. Construction waste can arise from material over-ordering, inaccurate estimating, design changes, poor storage and handling, construction errors, demolition and other project activities. Formoso et al. (2002) identified material waste as a significant construction-industry problem with implications for both project efficiency and environmental performance.

GSCM approaches waste from a supply-chain perspective rather than treating disposal as an isolated site activity. Waste prevention begins with design and procurement and continues through material delivery, storage, construction, recovery and end-of-life management.

Lu and Yuan (2011) reviewed construction and demolition waste-management research and developed a framework for understanding the field. Their work demonstrates the breadth of research concerning construction waste and the importance of systematic approaches to its management. Empirical research has also demonstrated that construction waste can be quantified through on-site measurement and sorting (Lu et al., 2011).

Waste-management strategies relevant to GSCM include:waste prevention at the design stage, accurate material estimation and procurement, appropriate storage and handling, segregation of waste at source, reuse of suitable materials, recycling of recoverable materials, recovery of materials from demolition, responsible disposal of residual waste, and monitoring of waste generation and recovery.

Reverse logistics can complement these practices by facilitating the return of recoverable materials into appropriate reuse, recycling or recovery channels. Such approaches move construction supply chains away from a purely linear model of procurement, use and disposal towards greater circularity.

The Nigerian regulatory framework also provides a formal basis for construction waste management. The National Environmental (Construction Sector) Regulations, 2011 provide for site waste-management requirements for new construction projects (Federal Republic of Nigeria, 2011).

Accordingly, ENV3 in this study measures the extent to which construction organizations implement systematic processes for reducing, segregating, reusing, recycling, recovering and appropriately disposing of construction waste.

Carbon-Emission Control (ENV4)

Carbon-emission control has become increasingly important within sustainable construction because buildings and construction supply chains generate emissions through material production, transportation, construction activities and building operation. Carbon management requires consideration of both embodied and operational emissions.

Embodied carbon is associated with activities such as extraction, processing, manufacture and transportation of construction materials. Operational emissions arise primarily during the use and operation of buildings. Pomponi and Moncaster (2016) reviewed evidence concerning embodied-carbon mitigation in the built environment and identified multiple strategies for reducing embodied carbon.

GSCM provides opportunities for carbon reduction through material selection, logistics optimization, energy efficiency, local sourcing where appropriate, waste reduction and consideration of lifecycle impacts. Life-cycle assessment can assist organizations in comparing environmental impacts associated with alternative materials and construction approaches (Cabeza et al., 2014).

Carbon-emission control can therefore include: selecting lower-carbon materials where technically appropriate, reducing unnecessary transportation, optimizing material-delivery logistics, reducing energy consumption during construction, minimizing construction waste, increasing the use of recovered or recycled materials where appropriate-assessing embodied carbon during design and procurement; and monitoring emissions associated with major project activities.

Nigeria's climate commitments provide an additional policy context. The Federal Government of Nigeria's 2021 updated Nationally Determined Contribution commits the country to an unconditional 20% reduction in emissions below business-as-usual levels by 2030 and a conditional 47% reduction subject to international support (Federal Government of Nigeria, 2021).

Carbon-emission control is therefore treated in this study as the extent to which construction organizations identify, monitor and reduce greenhouse-gas emissions associated with their supply-chain and project-delivery activities.

Biodiversity and Ecosystem Protection (ENV5)

Construction can affect biodiversity and ecosystems through land clearance, resource extraction, changes in land use, habitat disturbance, pollution and waste generation. Biodiversity considerations are therefore relevant to sustainable construction even where they are not traditionally included in conventional supply-chain decisions.

GSCM can incorporate ecosystem considerations through responsible material sourcing, environmental assessment, site planning, pollution prevention and resource conservation. The natural-resource-based perspective emphasizes the strategic importance of organizational responses to environmental constraints (Hart, 1995).

In Nigeria, environmental regulation includes provisions relevant to ecosystem protection. NESREA's regulatory framework includes regulations dealing with wetlands, riverbanks and lakeshores, watershed and catchment areas, endangered species, coastal and marine areas, soil erosion and forest and bush fires (NESREA, 2026). These regulations demonstrate that ecosystem protection forms part of Nigeria's wider environmental regulatory framework.
At the project level, biodiversity protection may include:appropriate site selection,minimizing unnecessary vegetation clearance,protecting sensitive ecological areas, controlling erosion and sedimentation;preventing pollution of surrounding ecosystems,sourcing materials responsibly,incorporating environmental assessment into project planning; and restoring disturbed areas where required.

For the purposes of this study, biodiversity and ecosystem protection refers to the extent to which construction organizations incorporate measures intended to avoid or minimize adverse impacts on ecosystems, habitats and biodiversity during building-project delivery.

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Eco-Design (ENV6)

Eco-design incorporates environmental considerations into the design of products, buildings and systems. In construction, eco-design can influence material selection, energy demand, water consumption, durability, adaptability, maintenance requirements and end-of-life recovery.

The significance of eco-design arises from the fact that many environmental consequences of a building are influenced by decisions made before construction begins. Life-cycle assessment provides a means of examining these consequences systematically. Cabeza et al. (2014) identify life-cycle assessment as an important approach for evaluating environmental impacts associated with buildings, while Zabalza Bribián et al. (2011) demonstrate its relevance to building-material selection.

Eco-design may therefore involve:selection of materials with lower environmental impacts,designing for durability and adaptability,reducing material requirements,improving energy performance,reducing water requirements;designing for maintenance and repair,facilitating reuse and recycling; and considering end-of-life recovery during initial design.

Eco-design is consequently adopted in this study as an indicator of the extent to which environmental considerations are incorporated into building design and material-selection decisions.

The literature establishes that environmental performance is a multidimensional component of GSCM. Pollution prevention addresses harmful emissions and discharges; resource conservation addresses efficient use of materials, energy and water; waste management addresses prevention, reuse, recycling and recovery; carbon-emission control addresses greenhouse-gas emissions; biodiversity protection addresses ecosystem impacts; and eco-design incorporates environmental considerations into early project decisions.

These six indicators are therefore retained as measurable components of the environmental dimension of GSCM in the present study. Their selection is consistent with established GSCM and sustainable-construction literature while allowing the study to examine environmental practices within the specific institutional and operational context of building construction project delivery in Southeast Nigeria.

III. METHODOLOGY

Research Design

This study adopts a mixed-methods research design to investigate Green Supply Chain Management (GSCM) in building construction project delivery in Southeast Nigeria. The quantitative component employs a structured questionnaire to obtain measurable information from construction professionals concerning GSCM practices and their perceived importance. The qualitative component provides contextual information and expert perspectives that complement the quantitative findings.

Mixed-methods research is appropriate where the research problem requires the integration of quantitative and qualitative information to obtain a comprehensive understanding of a phenomenon (Creswell & Plano Clark, 2018). In this study, the quantitative component provides empirical measurements of the identified GSCM components, while qualitative expert input provides additional contextual understanding and supports interpretation of the findings.

Target Population of the Study

The target population comprises construction professionals involved in building construction projects across the five states of Southeast Nigeria: Abia, Anambra, Ebonyi, Enugu and Imo. The professional categories include project managers, procurement personnel, engineers, builders, quantity surveyors, architects and other construction consultants whose responsibilities involve building-project delivery and supply-chain activities.

These professionals were selected because they are directly involved in decisions concerning construction procurement, material management, logistics, project execution, waste management and other activities relevant to GSCM.

The population frame used for the study comprises 1,703 building professionals identified from records obtained from relevant government ministries and professional associations in the five states.

Table 3.1: Population Distribution by State

S/N	State	Population
1	Imo	398
2	Abia	307
3	Anambra	318
4	Enugu	422
5	Ebonyi	258
Total		1,703

Source: Study population records, 2025.

Sample Size and Sampling Technique

*The study population comprises 1,703 bui*lding professionals. The respondents were selected from the population across the five states of Southeast Nigeria. The study employed a stratified sampling approach to ensure that respondents were drawn from each of the five states. The states constituted the geographical strata, after which respondents were selected from the identified population of construction professionals within each state. Stratification was considered appropriate because the study population is geographically distributed across five states.

Table 3.2: Respondents' Population and Sample Distribution

S/N	State	Population	Sample
1	Imo	398	193
2	Abia	307	171
3	Anambra	318	173
4	Enugu	422	203
5	Ebonyi	258	150
Total		1,703	890

Source: Field Survey, 2025.

The final sample comprises 890 respondents distributed across the five states. The relatively large sampling fraction provides a substantial number of observations for estimating the relative importance of the identified GSCM components.

Data Collection Instrument

A structured questionnaire was developed as the principal instrument for collecting the quantitative data. The questionnaire was organized according to the research objectives and the GSCM variables identified from the literature review.

For Objective One, Section B of the questionnaire focuses specifically on the key components of GSCM relevant to building construction project delivery. The questionnaire items were developed from the reviewed GSCM literature and adapted to the context of building construction in Southeast Nigeria. Previous GSCM research has employed structured measures for assessing green supply-chain practices, including green purchasing, environmental cooperation and related organizational practices (Zhu et al., 2005; Zhu et al., 2008).

The items were measured using a five-point Likert-type scale. The response categories ranged from 1 to 5, with higher values representing greater perceived importance of the respective GSCM component.

The questionnaire was subjected to expert review to establish content validity. The review considered the relevance, clarity, comprehensiveness and appropriateness of the questionnaire items in relation to the research objective. The Content Validity Index (CVI) was used as an additional basis for assessing the relevance of the questionnaire items. A CVI threshold of 0.80 was adopted as the criterion for retaining items. A pilot test was conducted before the main survey to assess the clarity and reliability of the questionnaire. Internal consistency was assessed using Cronbach's alpha. Cronbach's alpha is widely used to assess the internal consistency of multi-item measurement scales (Tavakol & Dennick, 2011).

Method of Data Analysis for Objective One

Data collected for Objective One were analyzed using the Relative Importance Index (RII). The RII is widely used in construction-management research to rank factors according to respondents' assessments of their relative importance. Gündüz, Nielsen and Özdemir (2013), for example, applied RII to rank factors affecting construction project performance.

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The RII was selected because the objective of the study is to identify and rank the relative importance of GSCM components based on respondents' assessments using a five-point rating scale.

The Relative Importance Index was calculated using the following formula: Mathematically, RII is expressed as:
$RII = \Sigma W / (A \times N)$
Where:

RII = Relative Importance Index;
W = weight assigned to each response;
A = highest possible weight on the measurement scale; and
N = total number of respondents.

For the five-point scale used in this study, $A = 5$.
The resulting RII values range from 0 to 1. Higher RII values indicate greater perceived relative importance of the corresponding GSCM component. The GSCM components were ranked in descending order according to their RII values.

The RII results were used to identify the GSCM components considered most important by construction professionals for building construction project delivery in Southeast Nigeria.

The RII method was selected because it provides a straightforward basis for comparing and ranking multiple factors assessed using a common rating scale. It has been applied extensively in construction research to prioritize factors according to respondents' perceptions (Gündüz et al., 2013).

The analysis was conducted using Microsoft Excel and/or appropriate statistical software for calculating the weighted responses, RII values and rankings.

IV. RESULTS AND DISCUSSION

This chapter presents the results of the data analysis and discusses the findings in relation to the first research objective. The chapter begins with the response rate and demographic characteristics of the respondents. This is followed by the analysis of the key components of Green Supply Chain Management (GSCM) in building construction project delivery in South-East Nigeria using the Relative Importance Index (RII). The findings are presented according to the environmental, economic, social, operational/technological, and regulatory/policy dimensions of GSCM.

Response Rate and Demographic Characteristics of Respondents

Table 4.1: Distribution of Respondents' Responses to Questionnaires

S/N	State	Samples Sent	Samples Retrieved	Response Rate (%)	Samples Used for Analysis
1	Imo	193	181	93.7	179
2	Abia	171	162	94.7	161
3	Anambra	173	168	97.1	165
4	Enugu	203	197	97.0	196
5	Ebonyi	150	146	97.3	143
Total		890	854	95.9	844

Source: Author's compilation from field survey data, 2025.

Table 4.1 shows the distribution of questionnaires administered, retrieved, and used for analysis across the five states. A total of 890 questionnaires were administered, of which 854 were retrieved, representing a retrieval rate of 95.9%. Following data screening, 844 questionnaires were considered usable for the analysis. Thus, 10 retrieved questionnaires were excluded from the analysis because they did not satisfy the study's usability requirements.

The 844 valid responses constituted the dataset used for the analysis presented in this chapter.

Table 4.2: Distribution of Respondents by Profession and State

S/N	Professional Group	Imo	Abia	Anambra	Enugu	Ebonyi	Total	Percentage (%)
1	Project Managers	15	11	14	14	7	61	7.23
2	Architects	31	20	22	28	17	118	13.98
3	Quantity Surveyors	34	28	27	35	28	152	18.01
4	Engineers	32	33	32	40	31	168	19.91
5	Estate Valuers	28	30	31	26	26	141	16.71
6	Builders	30	31	28	35	24	148	17.54
7	Others	9	8	11	18	10	56	6.64
Total							844	100.00

Source: Author's compilation from field survey data, 2025.

Table 4.2 indicates that the respondents comprised several professional groups involved in building construction project delivery. Engineers constituted the largest group, with 168 respondents (19.91%), followed by Quantity Surveyors with 152 respondents (18.01%) and Builders with 148 respondents (17.54%). Estate Valuers accounted for 141 respondents (16.71%), while Architects represented 118 respondents (13.98%). Project Managers and respondents in other professional categories accounted for 7.23% and 6.64%, respectively.

The distribution therefore provides representation from several professional groups involved in construction project planning, procurement, management, design, costing, and implementation.

Table 4.3: Distribution of Respondents by Academic Qualification

S/N	Academic Qualification	Frequency	Percentage (%)
1	B.Sc./B.Tech./B.Eng.	545	64.6
2	M.Sc./M.Eng.	269	31.9
3	PhD	30	3.6

Source: Author's compilation from field survey data, 2025.

Table 4.3 shows the academic qualifications of the respondents. The majority, 545 respondents (64.6%), possessed bachelor's-level qualifications, while 269 respondents (31.9%) possessed master's-level qualifications. A further 30 respondents (3.6%) possessed doctoral qualifications. The distribution indicates that the respondents generally possessed formal tertiary-level education relevant to their professional roles in the construction industry.

Table 4.4: Distribution of Respondents by Years of Industrial Experience

Years of Experience	Frequency	Frequency
Less than 5 Years	157	18.6
5–10 Years	196	23.2
11–15 Years	331	39.2
15 Years & Above	160	19.0
Total	844	100

Source: Author's compilation from field survey data, 2025

Table 4.4 the distribution indicates that 157 respondents (18.6%) had less than five years of professional experience, 196 respondents (23.2%) had between 5 and 10 years of experience, 331 respondents (39.2%) had between 11 and 15 years of experience, while 160 respondents (19.0%) had 15 years and above. The distribution demonstrates that the study included respondents with varying levels of professional experience, with a substantial proportion having more than ten years of experience.

Objective One: Key Components of GSCM in Building Construction Project Delivery

Objective One sought to identify the key components of GSCM relevant to building construction project delivery in South-East Nigeria. The Relative

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Importance Index (RII) was used to rank the identified components according to respondents' ratings. Higher RII values indicate higher relative importance among the components assessed.

Environmental Components

Table 4.5: Relative Importance Index of Key Environmental Components of GSCM

Component	SA (5)	A (4)	N (3)	D (2)	SD (1)	N	Weighted Score (ΣW)	RII	Rank
ENV1. Pollution Reduction Strategies	351	79	76	257	81	844	2,894	0.686	5th
ENV2. Resource Conservation Practices	372	274	45	95	58	844	3,339	0.791	1st
ENV3. Waste Management Systems	437	124	152	52	79	844	3,320	0.787	2nd
ENV4. Carbon Emission Control	376	222	93	93	60	844	3,293	0.780	3rd
ENV5. Biodiversity Protection Protocols	343	147	106	202	46	844	3,071	0.728	4th
ENV6. Eco-Design Integration	375	87	31	127	224	844	2,794	0.662	6th

Source: Author's field survey, 2025.

Note: SA = Strongly Agree; A = Agree; N = Neutral; D = Disagree; SD = Strongly Disagree; RII = Relative Importance Index.

Table 4.5 shows that Resource Conservation Practices (ENV2) ranked first among the environmental components, with an RII of 0.791. Waste Management Systems (ENV3) followed with an RII of 0.787, while Carbon Emission Control (ENV4) ranked third with an RII of 0.780. Biodiversity Protection Protocols (ENV5) ranked fourth with an RII of 0.728. Pollution Reduction Strategies (ENV1) and Eco-Design Integration (ENV6) ranked fifth and sixth, with RIIs of 0.686 and 0.662, respectively.

The results indicate that respondents placed relatively greater importance on resource conservation, waste management, and carbon emission control within the environmental dimension of GSCM.

Economic Components

Table 4.6: Relative Importance Index of Key Economic Components of GSCM

Component	SA (5)	A (4)	N (3)	D (2)	SD (1)	N	Weighted Score (ΣW)	RII	Rank
ECO3. Energy Efficiency Implementation	398	72	32	132	210	844	2,848	0.675	5th
ECO5. Market Competitiveness via Sustainability	344	80	74	195	151	844	2,803	0.664	6th
ECO2. ROI of Green Investments	389	81	94	119	161	844	2,950	0.699	3rd
ECO6. Operational Cost Savings	325	113	115	170	121	844	2,883	0.683	4th

ECO4. Access to Green Financing	327	239	55	164	59	844	3,143	0.745	2nd
ECO1. Cost-effectiveness of Green Materials	356	294	41	107	46	844	3,339	0.791	1st

Source: Author's field survey, 2025.
Note: SA = Strongly Agree; A = Agree; N = Neutral; D = Disagree; SD = Strongly Disagree; N = number of valid responses; Weighted Score (ΣW) = (SA×5) + (A×4) + (N×3) + (D×2) + (SD×1); RII = ΣW/(5×844).

Table 4.6 shows that Cost-effectiveness of Green Materials (ECO1) ranked first among the economic components, with an RII of 0.791. Access to Green Financing (ECO4) ranked second with an RII of 0.745, followed by ROI of Green Investments (ECO2), with an RII of 0.699. Operational Cost Savings (ECO6) ranked fourth with an RII of 0.683, while Energy Efficiency Implementation (ECO3) and Market Competitiveness via Sustainability (ECO5) ranked fifth and sixth, with RIIs of 0.675 and 0.664, respectively.

The result suggests that economic considerations associated with the affordability of green materials and access to financing were relatively more important to respondents than the other economic components assessed.

Social Components

Table 4.7: Relative Importance Index of Key Social Components of GSCM

Component	SA (5)	A (4)	N (3)	D (2)	SD (1)	N	Weighted Score (ΣW)	RII	Rank
SOC1. Public Awareness Programs	361	142	126	91	124	844	3,057	0.724	1st
SOC5. Stakeholder Engagement	270	187	103	164	120	844	2,855	0.677	5th
SOC2. CSR Initiatives	291	113	124	210	106	844	2,805	0.665	6th
SOC3. Ethical Labor Practices	282	178	99	166	119	844	2,870	0.680	4th
SOC6. Cultural Attitudes Toward Sustainability	319	123	131	195	76	844	2,946	0.698	2nd
SOC4. Green Skill Development	289	58	129	141	227	844	2,896	0.686	3rd

Source: Author's field survey, 2025.
Note: SA = Strongly Agree; A = Agree; N = Neutral; D = Disagree; SD = Strongly Disagree; N = number of valid responses; Weighted Score (ΣW) = (SA×5) + (A×4) + (N×3) + (D×2) + (SD×1); RII = ΣW/(5×844).

Table 4.7 indicates that Public Awareness Programs (SOC1) ranked first among the social components, with an RII of 0.724. Cultural Attitudes Toward Sustainability (SOC6) ranked second with an RII of 0.698, followed by Green Skill Development (SOC4), which recorded an RII of 0.686. Ethical Labor Practices (SOC3), Stakeholder Engagement (SOC5), and CSR Initiatives (SOC2) ranked fourth, fifth, and sixth, respectively.

The findings indicate that respondents placed relatively greater importance on awareness, sustainability-oriented cultural attitudes, and green skills within the social dimension of GSCM.

Operational/Technological Components

Table 4.8: Relative Importance Index of Key Operational/Technological Components of GSCM

Component	SA (5)	A (4)	N (3)	D (2)	SD (1)	N	Weighted (ΣW)	Score	RII	Rank
OP5. Lifecycle Assessment (LCA)	338	74	57	287	88	844	2,819		0.668	6th
OP6. Green Innovation	369	282	46	101	46	844	3,359		0.796	1st
OP3. Reverse Logistics	445	120	155	48	76	844	3,342		0.792	2nd
OP4. Supplier Collaboration	376	233	77	106	52	844	3,307		0.784	3rd
OP1. Green Procurement	349	145	114	214	22	844	3,117		0.739	4th
OP2. Sustainable Transportation	337	73	65	286	83	844	2,827		0.670	5th

Source: Author's field survey, 2025..

Note: SA = Strongly Agree; A = Agree; N = Neutral; D = Disagree; SD = Strongly Disagree; RII = Relative Importance Index.

Note: SA = Strongly Agree; A = Agree; N = Neutral; D = Disagree; SD = Strongly Disagree; N = number of valid responses; Weighted Score (ΣW) = (SA×5) + (A×4) + (N×3) + (D×2) + (SD×1); RII = ΣW/(5×844).

Table 4.8 shows that Green Innovation (OP6) ranked first among the operational/technological components, with an RII of 0.796. Reverse Logistics (OP3) ranked second with an RII of 0.792, followed by Supplier Collaboration (OP4), which recorded an RII of 0.784. Green Procurement (OP1) ranked fourth with an RII of 0.739, while Sustainable Transportation (OP2) and Lifecycle Assessment (LCA) (OP5) ranked fifth and sixth, with RIIs of 0.682 and 0.668, respectively.

The findings indicate that respondents placed relatively greater importance on green innovation, reverse logistics, and supplier collaboration within the operational/technological dimension of GSCM.

4.3.5 Regulatory/Policy Components

Table 4.9: Relative Importance Index of Key Regulatory/Policy Components of GSCM

S/N	Key Regulatory/Policy Components	SA (5)	A (4)	N (3)	D (2)	SD (1)	Sum	RII	Rank
1	RP2. Green Certifications	393	84	22	115	230	2,827	0.670	5th
2	RP4. Strategic Leadership	340	75	78	196	155	2,781	0.659	6th
3	RP3. Government Incentives	39	83	95	122	149	2,985	0.707	3rd
4	RP5. Sustainability Reporting	351	100	87	192	114	2,914	0.691	4th
5	RP6. International Standards Compliance	314	258	51	174	47	3,150	0.746	1st
6	RP1. Environmental Regulations	378	126	120	79	141	3,053	0.723	2nd

Source: Author's field survey, 2025..

Note: SA = Strongly Agree; A = Agree; N = Neutral; D = Disagree; SD = Strongly Disagree; RII = Relative Importance Index.

Table 4.9 shows that International Standards Compliance (RP6) ranked first among the regulatory/policy components, with an RII of 0.746. Environmental Regulations (RP1) ranked second with an RII of 0.723, followed by Government Incentives (RP3), with an RII of 0.707. Sustainability Reporting (RP5) ranked fourth with an RII of 0.691. Green Certifications (RP2) and Strategic Leadership (RP4) ranked fifth and sixth, with RIIs of 0.670 and 0.659, respectively.

The findings indicate that respondents placed relatively greater importance on compliance with international standards, environmental regulations, and government incentives within the regulatory/policy dimension of GSCM.

V. DISCUSSION

The findings of Objective One indicate that the key components of GSCM relevant to building construction project delivery in South-East Nigeria span environmental, economic, social, operational/technological, and regulatory/policy dimensions. The results should be interpreted as respondents' perceptions of the relative importance of the identified components rather than evidence of causal relationships.

Environmental Components

Resource Conservation Practices recorded the highest RII (0.791) among the environmental components, followed by Waste Management Systems (0.787) and Carbon Emission Control (0.780). This result indicates that efficient use of materials and other project resources, waste reduction and management, and control of emissions were relatively highly rated by respondents.

The finding is consistent with the broader GSCM literature, which identifies resource efficiency, waste reduction, environmental management, and integration of environmental considerations into supply-chain decisions as important elements of green supply-chain practice. It is also consistent with evidence from the Nigerian construction context. Osungbade et al. (2025), in a study of GSCM implementation among construction stakeholders in Asaba, Nigeria, identified green procurement, eco-design, reverse logistics, and technological innovation as relevant GSCM practices, while also reporting implementation challenges associated with cost, expertise, and regulatory enforcement.

The relatively lower ranking of Eco-Design Integration (RII = 0.662) does not imply that eco-design is unimportant in GSCM generally. Rather, it indicates that, within this respondent group and the set of environmental components assessed, respondents assigned comparatively lower relative importance to eco-design than to resource conservation, waste management, and carbon emission control.

Economic Components

Cost-effectiveness of Green Materials recorded the highest RII (0.791) among the economic components, followed by Access to Green Financing (0.745) and ROI of Green Investments (0.699). These results suggest that economic considerations remain an important aspect of GSCM implementation in building construction.

The finding is compatible with Nigerian research showing that cost and institutional conditions can affect the adoption of sustainable procurement practices. Ogunsanya et al. (2022) examined barriers to sustainable procurement in the Nigerian construction industry and identified, among other issues, perceived high costs of adopting sustainable solutions, inadequate sustainability knowledge, and regulatory and policy challenges.

The present finding should therefore be interpreted as evidence that respondents attach considerable importance to the economic feasibility of green materials and access to financing when considering GSCM components.

Social Components

Public Awareness Programs recorded the highest RII (0.724) among the social components, followed by Cultural Attitudes Toward Sustainability (0.698) and Green Skill Development (0.686). This result suggests that awareness, sustainability-oriented attitudes, and professional skills are relatively important social considerations in GSCM implementation.

This finding has relevance to previous Nigerian research on sustainable procurement. Ogunsanya et al. (2022), reported sustainability knowledge and awareness-related issues among the barriers identified in the Nigerian construction industry.

The result also indicates that GSCM implementation is not solely a technical or economic issue. Human knowledge, attitudes, and capacity can affect how sustainability requirements are understood and incorporated into construction procurement and project-delivery activities.

Operational/Technological Components

Green Innovation recorded the highest RII (0.796) among the operational/technological components, followed by Reverse Logistics (0.792) and Supplier Collaboration (0.784). These results indicate that respondents regarded technological innovation, recovery and reverse-flow processes, and collaboration with suppliers as relatively important operational components of GSCM.

The finding is broadly consistent with recent Nigerian construction research. Osungbade et al. (2025) examined GSCM implementation in construction projects in Asaba and specifically considered green procurement, eco-design, reverse logistics, and technological innovation. Their study also identified technological innovation as an important element in GSCM implementation.

The lower RII recorded for Lifecycle Assessment (0.668) should similarly be interpreted cautiously. It indicates a comparatively lower rating within this study rather than demonstrating that LCA is generally unimportant. Differences in technical capacity, familiarity with assessment methods, project requirements, or access to relevant information could potentially affect its practical application, although these factors were not directly tested in the present analysis.

Regulatory/Policy Components

International Standards Compliance recorded the highest RII (0.746) among the regulatory/policy components, followed by Environmental Regulations (0.723) and Government Incentives (0.707). This result indicates that respondents considered formal standards, environmental regulations, and government incentives to be relatively important components of GSCM in building construction project delivery.

The finding is consistent with Nigerian sustainable-procurement literature emphasizing the importance of policy and regulatory conditions. Oyewobi and Jimoh (2022) examined barriers and strategies associated with sustainable procurement in the Nigerian construction industry and identified government commitment and institutional capacity as important considerations for achieving sustainable procurement practices.

Similarly, Ogunsanya et al. (2022) identified national policy challenges and the adequacy and enforcement of regulatory frameworks among the issues associated with sustainable procurement in Nigeria.

The regulatory findings indicate that respondents recognize the role of formal standards, environmental requirements, and government support in shaping GSCM implementation. However, the RII analysis does not establish that these factors independently cause higher GSCM adoption or improved project performance.

Taken together, the RII results demonstrate that GSCM in building construction project delivery in South-East Nigeria is multidimensional. Within the environmental dimension, Resource Conservation Practices ranked highest; within the economic dimension, Cost-effectiveness of Green Materials ranked highest; within the social dimension, Public Awareness Programs ranked highest; within the operational/technological dimension, Green Innovation ranked highest; and within the regulatory/policy dimension, International Standards Compliance ranked highest.

These findings provide empirical support for treating GSCM as a combination of environmental, economic, social, operational/technological, and regulatory/policy considerations rather than as a single practice. The results also provide a basis for subsequent analysis in the study by identifying the

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components that respondents regarded as relatively important within each dimension.

The interpretation is limited to the respondents and study context and should not be generalized beyond the defined population without considering differences in construction practices, institutional conditions, and regional contexts.

VI. CONTRIBUTION TO KNOWLEDGE

This study contributes to knowledge in four principal ways:
First, it provides a context-specific GSCM framework for building construction project delivery in South-East Nigeria, addressing the gap in regionally focused GSCM research. The framework identifies key components across five dimensions: Environmental, Economic, Social/Human, Operational/Technological, and Regulatory/Policy/Strategic.
Second, it provides empirical evidence on the relative importance of GSCM components using the Relative Importance Index (RII). The study identifies the highest-ranked component within each dimension — Resource Conservation (ENV), Cost-effectiveness of Green Materials (ECO), Public Awareness (SOC), Green Innovation (OP), and International Standards Compliance (RP) offering a prioritised basis for decision-making by construction stakeholders.

Third, it contributes region-specific evidence from South-East Nigeria, complementing existing national and city-level studies on GSCM in the Nigerian construction industry and providing a basis for state-level policy development.

Fourth, it offers a practical framework that can guide construction professionals, policymakers, and stakeholders in integrating environmental considerations throughout the building construction supply chain.

The study also extends the natural-resource-based view of the firm (Hart, 1995) by demonstrating its application to construction supply-chain management in a developing-country context.

VII. PRACTICAL IMPLICATIONS

The results indicate that resource conservation, waste management, and carbon emission control are key to improving environmental performance in building construction projects. Environmental inefficiencies and cost overruns are often caused by poor material planning, inadequate waste segregation, and weak coordination between contractors, suppliers, consultants, clients, and regulatory agencies. Better green procurement planning, material reuse and recycling, energy-efficient construction processes, and supplier collaboration can optimize resource utilization, minimize waste generation, and improve project delivery outcomes. This reinforces the importance of integrating GSCM into overall project management systems.

Furthermore, the research indicates that green innovation, reverse logistics, and supplier collaboration can benefit decision-making and provide greater environmental visibility throughout the construction supply chain. In addition, strengthening awareness programmes, green-skill development, and compliance with environmental regulations and international standards is essential to reduce environmental uncertainty and enhance sustainable project delivery.

VIII. CONCLUSION

This study employed a quantitative survey design to identify and rank the key components of Green Supply Chain Management (GSCM) applicable to building construction project delivery in South-East Nigeria.The study subsequently employed the Relative Importance Index (RII) to assess the perceived relative importance of the identified GSCM components among construction professionals in South-East Nigeria. The components were examined across five contextual dimensions: environmental, economic, social/human, operational/technological, and regulatory/policy/strategic dimensions.

The findings demonstrate that GSCM in building construction is multidimensional and extends beyond environmental management alone. The five dimensions collectively capture the environmental, financial, human, technological, operational, and institutional considerations that influence the integration of green supply-chain practices into building construction project delivery.

The environmental dimension comprised six components: pollution reduction strategies, resource conservation practices, waste management systems, carbon emission control, biodiversity protection protocols, and eco-design integration. Based on the reported RII results, Resource Conservation Practices recorded the highest relative importance (RII = 0.791), followed by Waste Management Systems (RII = 0.787) and Carbon Emission Control (RII = 0.780). Biodiversity Protection Protocols recorded an RII of 0.728, while Pollution Reduction Strategies and Eco-Design Integration recorded RII values of 0.686 and 0.662, respectively. The findings indicate that resource conservation, construction waste management, and carbon-emission control are prominent environmental considerations in the application of GSCM to building construction projects in South-East Nigeria.

The economic dimension comprised cost-effectiveness of green materials, return on green investment, energy efficiency implementation, access to green financing, market competitiveness, and operational cost savings. Cost-effectiveness of Green Materials recorded the highest RII (0.791), followed by Access to Green Financing (0.745) and Return on Green Investment (0.699). Operational Cost Savings recorded an RII of 0.683, while Energy Efficiency Implementation and Market Competitiveness recorded RII values of 0.675 and 0.664, respectively. These results demonstrate the importance of economic considerations in the implementation of GSCM. In particular, the cost implications of sustainable materials and the availability of financing mechanisms are important considerations for construction professionals.

The social/human dimension consisted of public awareness programmes, corporate social responsibility, ethical labour practices, green-skill development, stakeholder engagement, and cultural attitudes toward sustainability. Public Awareness Programmes recorded the highest RII (0.724), followed by Cultural Attitudes Toward Sustainability (0.698) and Green Skill Development (0.686). Ethical Labour Practices recorded an RII of 0.680, while Stakeholder Engagement and CSR Initiatives recorded RII values of 0.677 and 0.665, respectively. These findings indicate that awareness, cultural orientation, and the development of appropriate green skills are important human and social considerations in strengthening GSCM implementation within the construction sector.

The operational and technological dimension comprised green procurement, sustainable transportation, reverse logistics, supplier collaboration, life-cycle assessment, and green innovation. Green Innovation recorded the highest RII (0.796), followed closely by Reverse Logistics (0.792) and Supplier Collaboration (0.784). Green Procurement recorded an RII of 0.739, while Sustainable Transportation and Life-Cycle Assessment recorded RII values of 0.682 and 0.668, respectively. The findings suggest that technological innovation, recovery and reuse of construction materials, and collaboration with suppliers are important operational mechanisms through which construction firms can improve the environmental performance of their supply chains.

The regulatory, policy, and strategic dimension comprised environmental regulations, green certification, government incentives, strategic leadership, sustainability reporting, and international standards compliance. International Standards Compliance recorded the highest reported RII (0.746), followed by Environmental Regulations (0.723). Government Incentives, Sustainability Reporting, Green Certifications, and Strategic Leadership recorded reported RII values of 0.707, 0.691, 0.670, and 0.659, respectively. The results demonstrate the importance of regulatory and institutional support in providing an enabling environment for GSCM implementation. Compliance with applicable standards and environmental regulations can provide a basis for improving accountability and consistency in sustainable construction practices.

Taken together, the findings indicate that the implementation of GSCM in building construction project delivery in South-East Nigeria requires attention to several interconnected areas. Environmental considerations provide an important foundation, but effective implementation also depends

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on economic feasibility, stakeholder awareness and competence, technological and operational capability, and an appropriate regulatory and institutional environment.

The results further indicate that GSCM should not be treated as a single construction activity or as a practice limited to waste management. Rather, it involves coordinated interventions throughout the construction supply chain, including material selection and procurement, supplier relationships, transportation, construction processes, material recovery, waste management, technological innovation, regulatory compliance, and stakeholder engagement.

The RII findings therefore provide empirical evidence for identifying and prioritising GSCM components according to their perceived relative importance among construction professionals in the study area. The results do not establish causal relationships between the identified components and project performance; rather, they demonstrate the relative importance attached to the components by the surveyed professionals.

In conclusion, the key components of GSCM for building construction project delivery in South-East Nigeria are multidimensional and comprise environmental, economic, social/human, operational/technological, and regulatory/policy/strategic considerations. The findings provide a context-specific evidence base for developing and implementing GSCM practices within the building construction sector in South-East Nigeria. The identified components can serve as a basis for policymakers, professional bodies, clients, contractors, consultants, suppliers, and other construction stakeholders seeking to strengthen sustainable supply-chain practices and improve the environmental and operational performance of building construction projects.

IX. RECOMMENDATIONS

Based on the findings of Objective One and the RII analysis, the following recommendations are made:

Institutionalise Resource Conservation and Waste Management Practices

Construction stakeholders should give increased attention to resource conservation and construction waste management. Regulatory agencies and professional bodies, including relevant construction and environmental authorities, should strengthen guidelines for efficient material utilisation, waste segregation, material recovery, reuse, and recycling. Contractors and suppliers should also incorporate material conservation and waste-reduction measures into project planning and execution.

Improve the Economic Feasibility of Green Construction Materials

The relatively high RII associated with the cost-effectiveness of green materials indicates the importance of economic considerations in GSCM implementation. Government agencies, clients, contractors, suppliers, and financial institutions should promote mechanisms that reduce the financial barriers associated with sustainable construction materials and technologies. Where appropriate, incentives such as concessional financing, grants, tax relief, and other support mechanisms may be developed to encourage investment in environmentally preferable materials and technologies.

Strengthen Green Financing Mechanisms

Financial institutions and relevant government agencies should develop financing arrangements that support sustainable construction investments. Such mechanisms could include appropriately structured green loans, sustainability-linked financing, grants, and other legitimate financial incentives. Improved access to green financing could assist construction firms in adopting environmentally preferable technologies and materials where initial investment costs constitute a barrier.

Enhance Awareness and Green-Skills Development

Professional institutions, educational institutions, government agencies, and construction organisations should strengthen continuous professional development in GSCM. Training should cover green procurement, sustainable material selection, waste management, resource efficiency, environmental compliance, life-cycle assessment, sustainable transportation, and other relevant GSCM practices. Increased awareness and professional competence can support the practical integration of green principles into construction project delivery.

5. Promote Green Innovation and Appropriate Digital Technologies
Construction organisations should promote innovation in materials, construction methods, energy efficiency, waste reduction, and supply-chain coordination. Where appropriate and economically feasible, digital technologies such as Building Information Modelling (BIM), life-cycle assessment tools, digital material tracking systems, and other project-management technologies should be incorporated into construction processes to improve information management, resource efficiency, and environmental decision-making.

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AUTHORS CONTRIBUTIONS

G. J.A. conceived the research idea, organized and supervised the study, and wrote the bulk of the manuscript. B.A. contributed to the research design and supervised the overall project. I.R.E. contributed to investigation, data analysis, and writing. F.E.U.U. contributed to literature review and data interpretation. C.O.E. contributed to investigation and data analysis. C.C.N. contributed to data analysis and writing. P.O.O. contributed to literature review and editing. All authors read and approved the final version of the manuscript.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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