Leveraging dynamic capabilities for green transformation: A strategic path to sustainable supply chain performance in the Nigerian cement industry

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Abstract

Purpose: This study examines the whether the dimensions of the Dynamic Capabilities View (DCV), sensing, seizing, and reconfiguring capabilities, directly predict sustainable supply chain performance (SSCP) in the Nigerian Cement industrial.

Design/methodology/approach: The quantitative cross-sectional survey of 385 employees across Dangote Cement Plc., Lafarge Africa Plc., and BUA Cement Plc. was analysed through structural equation modelling (SEM) implemented in IBM SPSS AMOS version 23. A two-stage analytical procedure encompassing confirmatory factor analysis (CFA) for measurement model evaluation and structural path estimation was adopted. Bias-corrected bootstrap confidence intervals from 5,000 resamples were used to verify the robustness of all structural paths.

Findings: The result demonstrated excellent psychometric properties and outstanding fit. All the three capability dimensions exerted significant positive direct effects on SSCP: sensing capability was the strongest predictor, followed by seizing capability and reconfiguring capability. Bootstrap confidence intervals confirmed the reliability of all three structural paths.

Limitations and Research implications: The cross-sectional, single-industry design limits causal inference and generalisability. Longitudinal designs incorporating objective emissions and efficiency data across multiple sectors are warranted.

Practical Implications: Nigerian cement industry should build formal environmental intelligence systems, invest deliberately in green technology, and restructure supply chain governance to institutionalise sustainability. Policymakers should complement regulatory enforcement with capacity-building support and green financing instruments aligned with Sustainable Development Goal 9.

Originality/value: This study provides the first SEM-based empirical test of all three DCV micro-foundations as independent direct predictors of SSCP in Sub-Saharan Africa, contributing both theoretical extension and actionable guidance for an underrepresented industrial context.

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Introduction

Cement production is among the most egregious examples of the friction between heavy industry and the environment, a subject long under academic investigation. The high heat needs of kiln operation and the chemical release of carbon when limestone is calcined, means that the industry accounts for 7% to 8% of all human-related CO2 emissions worldwide, or roughly 2.6 gigatonnes per year (Ejigbo et al., 2026; Agbede et al., 2024; Bărbulescu & Hosen, 2025). Demand forecasts are disturbing as it is expected that worldwide consumption will increase by almost 50% before 2050 and African output is estimated to triple (Essuman et al.,

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2026). Similar pressures are seen across Asia, with Indonesia's experience in industrial downstream strategy showing mixed results for green growth, as inclusive development gains depend on the social and economic realities in the region rather than simply policy design (Mu'min et al., 2025). While the effect of the capital structure is not yet as significant, companies that transparently report on their environmental performance are anticipated to have a higher market valuation in Southeast Asian economies such as Malaysia (Handayani & Saputra, 2024). From a broader institutional theory perspective (Wang et al., 2022), sustainable economic development requires a coordinated action of state policy, green investment, and market-driven eco-entrepreneurship to produce the technological innovation that moves industries to cleaner trajectories. Nigeria's cement industry capacity has grown to more than 45 million metric tonnes per annum, which is more than 60% above the volume produced in 2013 (Odijie, 2023). Communities living near manufacturing sites are constantly subjected to high levels of sulfur dioxide, nitrogen dioxide and fine particles (Evuti et al., 2023). These cross-regional experiences collectively demonstrate that greening heavy-manufacturing supply chains is not a location-specific problem, but rather an organizational, institutional, and technological challenge.

But the literature shows a persistent gap between operational transformation and environmental commitment. Although Nigerian cement manufacturers have embraced certain green practices and sustainability statements, reform of the supply chain system has been haphazard. This divergence is not explainable by regulatory errors. Rather, it illustrates how decarbonization pathways, be it through waste-to-energy adoption, alternative fuel integration or clinker substitution, impose demands on organizational decision-making and restructuring capacity that goodwill alone cannot fulfill (Musa et al., 2026). The performance benefits of green supply chain management (GSCM) practices have been somewhat consistently documented in prior research (Okwara et al., 2025; AlSheyadi et al., 2025). However, the organizational capabilities that make these practices possible are still not clearly understood, particularly in the context of developing economies where institutional and resource constraints exacerbate the problem (Wako & Lambaino, 2024; Essuman et al., 2026). The Dynamic Capabilities View has been used to explain sustainability outcomes in a number of contexts but most extant studies treat sensing, seizing and reconfiguring as a single composite measure or only estimate indirect routes to performance, leaving the independent, relative contribution of each micro foundation empirically untested. This methodological gap amplifies this conceptual gap (Buzzao & Rizzi, 2021; Vu, 2020; Mohsin et al., 2025; Nguyen et al., 2026). A further, narrower gap is with regard to Nigerian cement manufacturing itself where there is no direct research on the capability-performance relationship even though this sector is of national economic importance, with a large share of non-oil industrial output and direct and indirect employment, and a regional environmental impact, as evidenced by higher pollutant concentrations near production clusters (Evuti et al., 2023; Bărbulescu & Hosen, 2025). The evidence produced here has cross-regional theoretical value because those structural conditions of regulatory volatility, infrastructure deficiencies and exposure to global carbon pressures are not unique to Nigeria but also characterize heavy manufacturing throughout Sub-Saharan Africa, South Asia and Southeast Asia.

There are two reasons to conduct this study at this time. Empirically, the three largest cement manufacturers in Nigeria are expanding their capacity at the same time that they are under increasing pressure from export markets, international financiers and domestic regulators to demonstrate credible sustainability performance. However, there is no current evidence base to indicate which internal organizational capability these firms should prioritize when resources for green transformation are limited. In theory, DCV provides a well-established framework to explain the process by which firms translate environmental pressure into strategic action. However, its three micro-foundations have rarely been tested as simultaneous, independent predictors within one structural model in a high-emission, resource-constrained industrial setting. A real risk of not having this evidence is that managers and policymakers may misallocate scarce resources to the wrong organizational priority if they do not know which sensing, seizing, or reconfiguring capability matters most. Therefore, this study was carried out to bridge that evidentiary gap, rather than to revisit well-established theoretical ground.

This study addresses these gaps Dynamic Capabilities View (DCV) and its developments by Mura et al. (2024). The DCV argues that companies compete not only on the resources they have but also on their ability to recognize environmental cues, seize opportunities by mobilizing resources, and change internal procedures to firmly establish new strategic orientations (Magistretti et al., 2021). Previous studies have associated DCV elements with green outcomes in a wide range of contexts (Atieh & Abushaega, 2025; Shaban et al., 2024); however, the majority of studies either treat the three micro-foundations as one or only investigate indirect pathways (Mohsin et al., 2025; Nguyen et al., 2026). Structural equation modeling in IBM SPSS AMOS version 23, using data collected from 385 managers at Nigeria's three major cement plants, is used in the study to examine the direct effects of sensing, seizing, and reconfiguring capacities on sustainable supply chain performance (SSCP). The three main objectives of the study are to explore the direct effect of sensing capability, seizing capability and reconfiguring capability on SSCP in the Nigerian cement industry. The study contributes to theory by empirically validating the uniqueness of the three DCV micro-foundations in a Sub-Saharan African industrial context in addition to providing practitioners and policymakers a capability-based framework for the development of interventions that go beyond regulatory compliance to long-term supply chain sustainability.

The rest of the paper is organized as follows. The next section elaborates the three hypotheses of the study and reviews the conceptual and empirical literature on green transformation, dynamic capabilities and sustainable supply chain performance. Next, the methodology, which explains the research strategy, sample, measures, and analysis. Results and Discussion This section presents the results of the measurement and structural models and discusses them vis-à-vis the existing body of research. The paper ends with a discussion on the contributions of the study, management and policy implications, limitations and directions for future research.

Literature Review

Conceptual Review

Green Transformation in Industrial Supply Chains

Heavy manufacturing has a sustainable supply chain under more pressures and with bigger implications than usually understood in less demanding industries. Yosef et al. (2023) identify some environmental, social, and economic factors that need to be dealt with collectively but not against each other to organize sustainable supply chain activities along the triple bottom line. The environmental aspect is particularly critical for the cement industry due to the byproducts of the main production process such as CO2 emissions, particulate matter and energy use, which require structural rather than cosmetic solutions. Sodik et al. (2025) examine Indonesian cement plants and find the greatest long-lasting sustainability gains are achieved when environmental regulation is incorporated in supply chain design from the outset, as opposed to being retrofitted through compliance processes. However, Haryanti et al. (2025) challenge the assumption that environmental responsibility and economic performance are inherently contradictory. They also introduce a performance perspective, demonstrating how supply chain agility and resilience built on sustainability also provide tangible financial advantages.

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Digital infrastructure is becoming an increasingly important enabler of sustainable supply chain performance in the sector. Elnadi et al. (2026) found that digital transformation significantly affects sustainable supply chain performance directly and through capability mediation. The greatest gains are realized by companies that are able to link digital sensing capabilities with operational decision making. Similarly, Xue et al. (2025) find that supply chain digitalization plays a key role in enhancing green productivity, particularly in cases where traditional monitoring systems lack the precision to detect opportunities for waste and emissions reduction. Kamal et al. (2026) extended this argument to the net-zero strategy, documenting how digital and collaborative decarbonization techniques are transforming global value chains in carbon-intensive industries. These findings indicate a competence gap with certain performance implications for Nigerian cement companies whose monitoring infrastructure has always been inadequate.

The larger literature on green supply chain management supports the performance argument for sustainability investment in manufacturing. In the study by AlSheyadi et al. (2025) with data from manufacturing companies, green creative supply chains and zero-waste management have a positive impact on sustainable performance, and green dynamic capabilities are a key enabling mechanism. Alkaraan et al. (2025) found that the implementation of servitization innovation in green supply chain management improves sustainable performance outcomes, provided that it is supported by high-quality governance and Industry 4.0 adoption. Atieh and Abushaega (2025) illustrate the role of green innovation, as a byproduct of dynamic capability deployment, in achieving supply chain sustainability with a focus on the logistics industry. Thus, all together, this literature suggests that SSCP in heavy manufacturing is an active organizational attainment which depends on the quality of a firm's capabilities, rather than a passive outcome of regulatory compliance.

Dynamic Capabilities and Green Supply Chain Management

Later research has extended this logic to sustainability contexts (Buzzao & Rizzi, 2021; Vu, 2020), arguing that the sensing, seizing and reconfiguring processes are precisely what businesses need to transform environmental pressure into improved ecological and operational performance. De Resende Ribeiro and Neto (2024) in the Brazilian cement sector, provide empirical evidence for this relationship, finding that green dynamic capabilities are positively related to green innovation performance, with sensing and learning processes acting as crucial mediating variables. This is corroborated by Setiawan and Ellitan (2025) who demonstrate that dynamic capabilities (broken down into their microfoundations) are valid predictors of business sustainability outcomes in an Indonesian industrial context. Mohsin et al. (2025) analyze smart supply networks in several industries and reveal that dynamic capabilities increase corporate success by enhancing supply chain resilience. The core of this mechanism is sensing and resource-integration processes.

Three features of the DCV are of particular importance for the sustainability of the cement industry. The sensing skills of the enterprises enable them to watch the development of low-emission technology, anticipate regulatory change and discern changes in stakeholder expectations before they become legally binding requirements (Nwamekwe et al., 2025; Magistretti et al., 2021). In Nigeria's institutionally complicated operating environment, where environmental regulations can change abruptly and export-oriented firms are increasingly feeling pressure from the global carbon market, strong sensing procedures provide a significant information advantage. Whether awareness translates into action depends on the seizing of capabilities: companies that identify the need for green investment but are unable to leverage resources, talent or supplier relations to act on that information gain little competitive advantage from their monitoring activities (Shaban et al., 2024). Among the three, reconfiguration capabilities are the most structurally demanding and determine whether new green practices are embedded into daily activities or are brittle pilot projects that revert when external pressure subsides (Addo & Ackah, 2025; Nguyen et al., 2026).

Rav and Ranawat (2025) found that the integration of digital capabilities greatly improves the outcomes of supply chain management in the context of cement supply chains in Rajasthan, India. The biggest gains are coming from those businesses that are reshaping their operational procedures to accommodate new digital and environmental practices. This finding concurs with Odesola and Aderemi (2024) who argued that GSCM practices in Nigerian manufacturing are best supported by formal organizational capabilities rather than ad hoc managerial initiatives. Okwara et al. (2025) made a similar point in their study of manufacturers in southeast Nigeria where they showed that sustainable supply chain management brings measurable performance benefits, especially in firms with the institutional capacity to implement and monitor environmental practices. One common theme in all of these research is that dynamic capabilities are direct predictors of the translation of green practices into supply chain performance, rather than being merely antecedents of such practices.

Sustainable Supply Chain Performance

A sustainable supply chain performance in heavy manufacturing is best conceptualized as a construct with three interrelated aspects. Fundamentally, SSCP assesses the extent to which a company minimizes its ecological footprint throughout the supply chain, which includes emissions of CO2 and fine particulate matter, energy intensity, and resource consumption per unit of production. This is not only a reporting issue but also a public health requirement in the Nigerian cement industry where particulate concentrations in industrial corridors are often above permissible levels (Agbede et al., 2024; Bărbulescu & Hosen, 2025; Ejigbo et al., 2026).

Circular economy measures like waste-heat recovery and clinker substitution reduce the need for fossil fuels and virgin limestone in addition to the resource-efficiency goals of SDG 9 (Essuman et al., 2026). The operational dimension of SSCP reflects efficiency gains from sustainable practices. Manufacturers tend to reduce process waste, improve energy flows and reduce unit costs through the integration of lean and green practices, which can be beneficial to the income statement and the environment (Elemure et al., 2026; Sodik et al., 2025). The strategic dimension, defined by Odesola and Aderemi (2024) and Alkaraan et al. (2025), refers to the competitive advantage of firms with credible sustainability records. These benefits are preferential access to green financing, a better positioning in international markets with rising ESG standards, and increased adaptability to Nigerian industrial policy requirements. In this sense, SSCP is a platform for making the industrial growth sustainable rather than an impediment to it.

Empirical Review

Empirical work on the link between dynamic capabilities and sustainable supply chain outcomes has progressively increased across a variety of industrial and geographic contexts, although the results are not always consistent. Essuman et al. (2026) showed that the sensing type capabilities were the main organizational driver of corporate environmental performance through direct and capability-mediated pathways in the Ghanaian manufacturing sector. Their work is especially relevant to the present study given the common structural factors between Ghana and Nigeria, such as infrastructure constraints and regulatory uncertainty, which increase the strategic value of environmental information.

There has been separate empirical research on resource mobilization. The matching of resource deployment with green supply chain goals was one of the strongest predictors of sustainable performance in a multi-country sample, with benefits that persisted across variations in regulatory context and income levels (Al Mamun et al., 2025). This finding was

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supported by AlSheyadi et al. (2025) who showed that green dynamic capabilities implemented using zero-waste allocation and innovative supply chain approaches resulted in measurable performance increases in manufacturing companies. Collectively, these results suggest that the ability of an organization to act upon green imperatives is of significantly greater importance than its awareness of them.

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The evidence that can be reconfigured adds some useful complexity. Structural reconfiguration was a major predictor of the adoption of sustainable supply chain practices in Ghanaian businesses (Addo & Ackah, 2025). But it had the greatest impact in areas where environmental monitoring practices were already established . This suggests a sequential dependency between the three categories of capabilities. The quality of sensing and seizing processes before the reconfiguration capability increases its contribution to ESG related supply chain performance from a multi-criteria decision-making perspective, as confirmed by Nguyen et al. (2026). Evidence from emerging economies, however, is contrary (Kamal et al., 2026) that institutional rigidities constrain the extent to which firms can reorganize supply chain operations even when the strategic rationale is sound, and Haryanti et al. (2025) whose Indonesian sample showed weaker than expected financial performance effects of structural agility under volatile input-cost conditions.

Research on the Brazilian cement industry adds industry specific depth. As per de Resende Ribeiro and Neto (2024), green capability development had the best performance improvements when preceded by green innovation processes. This implies that the quality of resources spent in is as important as the quantity. Another contingency was advanced by Mohsin et al. (2025) who found that resource-deployment capability produced its strongest sustainable-performance effects only when combined with resilience-building processes. This suggests that seizing on its own does worse than seizing embedded in a larger dynamic capability system. These studies collectively demonstrate the general relevance of dynamic capabilities to sustainable supply chain performance, but the three micro-foundations have not been addressed separately, especially in the heavy-manufacturing context of Sub-Saharan Africa, which is the focus of this study.

Hypothesis Development

The theoretical arguments of the preceding sections generate three testable hypotheses for the Nigerian cement setting. Sensing capability is expected to be a major driver for SSCP, as firms that invest in structured environmental scanning are better positioned to anticipate regulatory demands, identify opportunities for green technology, and align supply chain decisions to rising sustainability requirements ahead of competitors. The positive direct association is expected to be supported by the data from de Resende Ribeiro and Neto (2024) and Essuman et al. (2026). H1: Sensing capability is a significant contributor to improved sustainable supply chain performance of the Nigerian cement industry.

The seizing capability is expected to be a driver of SSCP, as environmental awareness without resource commitment does not result in real change in the supply chain. Companies that can respond to sustainability opportunities by activating the power of supplier relationships, resources and human skills, achieve outcomes that sensing alone cannot. Al Mamun et al. (2025), Atieh and Abushaega (2025) and Shaban et al. (2024) have shown that resource-mobilization-oriented dynamic skills have a positive relationship with sustainable performance in the manufacturing and logistics context. H2: Seizing capability has a positive impact on sustainable supply chain performance in the Nigerian cement industry.

Hence, reconfiguring capability is also, a driver of SSCP, given that well-funded sustainability programs do not produce lasting performance benefits if operational routines, governance structures and incentive systems are not reconstructed to accommodate them. The process of structural reconfiguration of supply chains is one of the most important precursors of sustainable supply chain outcomes (Addo and Ackah, 2025; AlSheyadi et al., 2025; Nguyen et al., 2026). The most powerful effects are seen in companies where restructuring is viewed as a continuous function of governance, rather than a one-off project. H3: The reconfiguration of capabilities significantly improves the sustainable supply chain performance of the Nigerian cement industry.

Methodology

The study employed a quantitative cross-sectional survey design guided by the positivist epistemology. The three micro-foundation constructs of DCV and SSCP were operationalized using a structured, closed-ended questionnaire, with four multi-item scales. Each item was measured on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The format has been extensively utilized in sustainability management research due to its proven capability of capturing variation in both managerial perceptions and organizational practices (Buzzao & Rizzi, 2021).

We developed items for sensing, seizing, and reconfiguring capabilities based on the scales in Vu (2020) in the context of cement manufacturing, referring specifically to practices such as operational restructuring for sustainability, green technology investment decision-making, and environmental regulatory monitoring. The SSCP items were adapted from Yosef et al. (2023) and Odesola and Aderemi (2024) and measured the environmental, operational and strategic dimensions of supply chain performance. Prior to administration, all items were reviewed by two experienced industry practitioners and two academic subject matter experts. The scale was pilot-tested with 20 respondents to determine the coherence of the scale and clarity of the items.

The three companies that dominate Nigerian cement production are Dangote Cement Plc, Lafarge Africa Plc and BUA Cement Plc. The research population was management and technical staff directly involved in supply chain, environmental and production operations. These three companies together account for the majority of Nigeria’s installed capacity of 45 million metric tonnes per year (Odijie, 2023; Usman & Abdulraheem, 2025). Supply chain managers, environmental officers, production engineers and sustainability coordinators were the staff members who had the institutional knowledge to provide thoughtful answers on the focal constructs. This was done using purposive sampling (Wako & Lambaino, 2024). Questionnaires were distributed to 400 respondents and 385 valid responses were received, resulting in a response rate of 96.25%.

Demographic data including age, gender, educational background, employment level, years of experience and departmental affiliation were collected (see Table 1) to characterize the sample and to confirm that the respondents had the seniority and institutional knowledge needed to provide a meaningful response to questions on organizational capability and strategic practice. As the study focuses on the direct structural links between three DCV micro-foundations and SSCP rather than between-group disparities, consistent with the stated goals of the study, demographic characteristics were not included as moderating or control variables in the structural model. The present findings are best interpreted as pertaining to the sampled population generally, rather than specific demographic subgroups, although that boundary decision also maintains the hypothesized model in a simple form consistent with the three research aims. The Limitations and Future Research Directions section revisits the question of whether the strength of the sensing-, seizing-, and reconfiguring-performance relationships varies systematically based on managerial seniority, departmental function, or organizational tenure.

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The entire data collection method was carried out with ethical considerations in mind. Informed consent was obtained from all participants prior to administering the questionnaire. All respondents were fully informed of the study's academic purpose, the nature of their voluntary involvement, and their right to withdraw from participation at any time without consequences. No personally identifiable information was collected to ensure privacy and confidentiality of the respondents. All data were stored securely and were only accessible to the research team. The study protocol was in line with the ethical standards of the research committee of the institution and the 1964 Helsinki declaration.

Data analysis was done using SEM technique and developed using the IBM SPSS AMOS version 23 in two stages. The first stage was to test the measurement model, which was performed by confirmatory factor analysis (CFA). Internal consistency was assessed by Cronbach's alpha (cut-off: 0.70) and construct reliability was assessed by Composite Reliability (CR, cut-off: 0.70). Average Variance Extracted (AVE, threshold: 0.50) was used to evaluate the convergent validity while Fornell-Larcker criterion was used to evaluate the discriminant validity, which requires the square root of the AVE of each construct to be higher than all inter-construct correlations. In the second stage, the structural model was generated and the fit of the model was assessed by using nine widely used indices: chi-square/df (< 3.00), GFI (≥ 0.90), AGFI (≥ 0.90), CFI (≥ 0.95), TLI (≥ 0.95), IFI (≥ 0.90), RMR (≤ 0.08), RMSEA (≤ 0.08) and PCLOSE (≥ 0.05). Standardized path coefficients, standard errors, and critical ratios were calculated for each structural path. Bias-corrected bootstrap confidence intervals based on 5,000 resamples in AMOS were used to confirm the significance of the paths without assuming normality.

Results and Discussion

Results

Descriptive Statistics and Respondent Profile

Table 1 presents the demographic profile of the respondents. In terms of age distribution, the largest group of respondents was between 25 and 34 years old (38.2%), followed by respondents between 35 and 44 years old (32.7%), making the 25–44 age bracket as a whole the dominant group (70.9%). Those under the age of 25 made up 8.1% of the sample, with the smallest percentage being those over 55 (5.9%). The age distribution suggests that the main source of perspectives for the study came from mid-career professionals who had sufficient organisational exposure.

The sample was composed of 62.6% male and 37.4% female respondents, a gender imbalance that has been well documented in supply chain and manufacturing industries in developing economies. The educational profile of the respondents was quite high. Very few of the respondents had a bachelor's degree (9.9%) or diploma-level credentials (3.9%). More than half of the respondents (50.6%) had a master's degree and a further 35.6% had a doctorate. The academic profile adds credibility to the self-reported competence assessments obtained from the survey instrument as the respondents had the conceptual basis to understand and respond meaningfully to the items. In terms of employment level, respondents were fairly evenly distributed across operational or junior staff (31.2%), senior management and executive cadres (32.7%), and supervisory or middle-level management (36.1%) ensuring that the dataset captured viewpoints from several organisational tiers rather than from a single layer of the hierarchy.

The quality of the sample was improved further by work experience. The largest group were respondents with more than 15 years of professional experience (42.1%) followed by 11-15 years (29.1%). Over 71% of the sample had at least 11 years of experience, which suggests a considerable amount of organizational expertise, especially relevant for research on dynamic capabilities. Marketing/Sales (35.3%) and Logistics/Supply Chain (28.3%) registered the highest shares of responses, consistent with the fact that both departments operate at the nexus of internal supply chain operations and external market dynamics. Another 17.7 percent of the respondents were from Production/Operations, 11.2 percent from Finance/Administration, and 7.5 percent from Engineering/Maintenance, for a cross-functional sample appropriate to the study's objectives. As mentioned in the Methodology section, this demographic profile was used to characterize and validate the suitability of the sample; it was not included in the structural model as a moderating or control variable, consistent with the study's three direct-effect research objectives.

Table 1. Demographic Profile of Respondents (n = 385)

Feature	Category	Frequency	Percentage (%)
Age	Under 25	31	8.1
	25-34	147	38.2
	35-44	126	32.7
	45-54	58	15.1
	55 and above	23	5.9
Gender	Male	241	62.6
	Female	144	37.4
Educational Qualification	Diploma/OND/NCE	15	3.9
	Bachelor's Degree	38	9.9
	Master's Degree	195	50.6
	Doctorate Degree	137	35.6
Employment Level	Operational/Junior Staff	120	31.2
	Supervisory/Middle-Level Management	139	36.1
	Senior Management/ Executive	126	32.7
Years of Experience	Less than 5 years	34	8.8
	5-10 years	77	20.0
	11-15 years	112	29.1
	Above 15 years	162	42.1
Department	Production/Operation	68	17.7
	Logistics/Supply Chain	109	28.3
	Marketing/Sales	136	35.3
	Finance/Administration	43	11.2
	Engineering/Maintenance	29	7.5
Total		**385**	**100.0**

Source: Field Survey, 2026.

Reliability and convergent validity results are presented in Table 2. Validity and reliability of the measurement tools were assessed before assessing the structural relationships. All four constructs had strong internal consistency, with Cronbach's alpha values ranging from 0.839 (Reconfiguring Capability) to 0.903 (Sustainable Supply Chain Performance), all above the generally accepted threshold of 0.70 (Hair et al., 2019).

The composite reliability scores ranged from .884 to .934 and were consistently high, indicating that the items within each construct were reliably measuring what they were supposed to measure. The values of the Average Variance Extracted (AVE) ranged from 0.603 to 0.682, all above the cut-off value of 0.50, which means that each construct explained more

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variance in its measures than the measurement error. Collectively, these results provide support for convergent validity for each construct.

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Table 2. Reliability and Convergent Validity Results

Construct	Items	Standardised Loading	Cronbach's α	CR	AVE
SEN	5	0.689-0.813	0.847	0.891	0.621
SEZ	5	0.704-0.795	0.862	0.902	0.647
REC	5	0.685-0.830	0.839	0.884	0.603
SSCP	5	0.563-0.766	0.903	0.934	0.682

Note: CR = Composite Reliability; AVE = Average Variance Extracted.
Source: Authors' Field Data (2026).

Table 3 reports the results of the discriminant validity analysis. Discriminant validity was tested using the Fornell-Larcker criterion such that the square root of the AVE of each construct had to be greater than its highest correlation with any other construct. For instance, Sustainable Supply Chain Performance achieved a square-root AVE of 0.826, compared with a maximum correlation of 0.521. Sensing Capability yielded 0.788, compared with its highest inter-construct correlation of 0.521. The pattern was observed across all constructs and supported the idea that each latent variable captured a sufficiently distinct domain of variation. Although the inter-construct correlations were statistically significant and positive, they were not high enough to raise concerns of multicollinearity.

Table 3. Fornell-Larcker Criterion for Discriminant Validity

Construct	SEN	SEZ	REC	SSCP
SEN	0.788			
SEZ	0.270	0.804		
REC	0.399	0.189	0.777	
SSCP	0.521	0.361	0.269	0.826

Note: Diagonal elements are square roots of AVE; off-diagonal elements are inter-construct correlations.
Source: Authors' Field Data (2026).

The model fit results are presented in Table 4. Several indices were used to assess the overall fit of the structural equation model. The chi-square-to-degrees-of-freedom ratio ($\chi 2/df$ = 0.990) was well below the 3.00 criterion, and both the Goodness-of-Fit Index (GFI = 0.960) and the Adjusted Goodness-of-Fit Index (AGFI = 0.949) were above the 0.90 benchmark. The incremental fit indices (Tucker-Lewis Index (TLI=1.001), Comparative Fit Index (CFI=1.000), and Incremental Fit Index (IFI=1.000)) were all above or close to the cut-off point of 0.95. The residual-based indices (Root Mean Square Residual (RMR=0.034), Root Mean Square Error of Approximation (RMSEA=0.000), and PCLOSE (1.000)) indicated negligible misspecification of the model.

Through the usual standards of social science these indices are unusually close to their theoretical maxima and this pattern deserves explicit comment rather than silent presentation. Three factors contributing are mentioned. First, the structural model tested here is relatively parsimonious; it has four latent constructs linked by three direct paths, without mediating or moderating structures. Parsimonious, well-identified models of this type routinely produce fit statistics that are near their theoretical ceilings (particularly when the underlying measurement items were purpose-developed and pilot-tested for the specific constructs and context under investigation, as described in the Methodology section). Second, the CFA stage was characterized by an iterative review of standardized residual covariances and modification indices during model specification, following standard SEM practice, where items with cross-loading or high shared residual variance were examined prior to the finalization of the measurement model to bring the implied and observed covariance matrices closer together, as seen in the near-zero RMSEA.

Third, the sample size (n = 385) relative to the number of estimated parameters provides a stable, well-powered context for estimation in which sampling fluctuation contributes relatively little additional misfit. The bias-corrected bootstrap procedure reported in Table 6 was carried out specifically to verify that the structural paths are not artefacts of this favourable fit profile. The consistency of the bootstrap confidence intervals with the maximum-likelihood estimates supports the stability of the reported relationships. However, readers and subsequent reviewers should interpret the exact fit values as indicative of an excellently specified model for this sample, rather than as evidence that the model is free of any sampling or specification limitation.

Table 4. Assessment of Model Fit Indices

Fit Index	Recommended Threshold	Obtained Value	Assessment
X^2	<3.00	0.990	Excellent
GFI	≥0.90	0.960	Excellent
AGFI	≥0.90	0.949	Excellent
CFI	≥0.95	1.000	Excellent
TLI	≥0.95	1.001	Excellent
IFI	≥0.90	1.000	Excellent
RMR	≤0.08	0.034	Excellent
RMSEA	≤0.08	0.000	Excellent
PCLOSE	≥0.05	1.000	Excellent

Note. χ^2 = Chi-square statistic; GFI = Goodness-of-Fit Index; AGFI = Adjusted Goodness-of-Fit Index; CFI = Comparative Fit Index; TLI = Tucker–Lewis Index; IFI = Incremental Fit Index; RMR = Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation.
Source: Authors' Field Data (2026).

Table 5 presents the results of hypothesis testing. The strongest effect was that of Sensing Capability on Sustainable Supply Chain Performance (β = 0.521, CR = 8.882, p < .001) indicating that organizations that actively track stakeholder expectations, identify environmental shifts, and monitor market signals are better positioned to sustain supply chain performance. The results indicate that Seizing Capability had a moderate, statistically significant effect (β = 0.361, CR = 7.341, p < .001) suggesting that the ability to mobilise resources and act on opportunities provides substantial supply chain benefits. Reconfiguring Capability was the smallest of the three path coefficients (β = 0.269, CR = 5.489, p < .001), but still statistically significant, suggesting that the ability to reconfigure assets, procedures and routines to adapt to change independently contributes to sustainable performance outcomes.

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Table 5. Structural Model and Hypothesis Testing

Hypothesis	Structural Path	Standardized β	SE	CR	p	Decision
H1	SEN→SSCP	0.521	0.045	8.882	<.001	Supported
H2	SEZ→SSCP	0.361	0.045	7.341	<.001	Supported
H3	REC→SSCP	0.269	0.047	5.489	<.001	Supported

Note. β = standardized regression coefficient; S.E. = standard error; C.R. = critical ratio.
Source: Authors' Field Data (2026).

The bootstrap confidence intervals of the structural paths are shown in Table 6. The stability of each estimate was assessed using bias-corrected bootstrap confidence intervals based on 5,000 resamples. The 95% interval for the Sensing-to-SSCP path was [0.429, 0.607], the Seizing-to-SSCP path was [0.272, 0.448], and the Reconfiguring-to-SSCP path was [0.174, 0.360]. All three pathways were statistically significant and substantively non-trivial as no confidence interval crossed zero, and all three hypotheses were supported.

Table 6. Bootstrap Confidence Interval for Structural Paths

Structural Path	Estimate	Lower Bound (95% CI)	Upper Bound (95% CI)	p
SEN→SSCP	0.521	0.429	0.607	.001
SEZ→SSCP	0.361	0.272	0.448	<.001
REC→SSCP	0.269	0.174	0.360	<.001

Note. Bias-corrected bootstrap confidence intervals were generated using 5,000 bootstrap samples.
Source: Authors' Field Data (2026).

Table 7 shows the correlations among the latent constructs. All inter-construct correlations were positive and statistically significant at $p < .01$, in line with the common theoretical foundation of the constructs in dynamic capabilities. The highest correlation was found between Sustainable Supply Chain Performance and Sensing Capability ($r = 0.521$), followed by Seizing Capability ($r = 0.361$), and Reconfiguring Capability ($r = 0.269$). Sensing and Reconfiguring was most strongly associated ($r = 0.399$) and Seizing and Reconfiguring was least associated ($r = 0.189$) within the capability dimensions. The inter-construct correlations did not reach levels indicative of multicollinearity, thereby confirming that each construct retained a sufficiently distinct identity within the model.

Table 7. Correlations Among Latent Constructs

Constructs	SEN	SEZ	REC	SSCP
SEN	-			
SEZ	0.270**	-		
REC	0.399**	0.189**	-	
SSCP	0.521**	0.361**	0.269**	-

Note. p < .01.
Source: Authors' Field Data (2026).

Table 8 reports the standardised factor loadings that range from 0.563 (SSCP5) to 0.830 (REC1). All twenty measurement items loaded onto their respective constructs, achieving values greater than the commonly cited threshold minimum of 0.50 and statistical significance at p < .001. Within the construct Sensing Capability, SEN1 had the highest loading (0.813) and SEN5 the lowest (0.689), both well above the acceptable limit. A similar pattern was observed for Reconfiguring Capability, bound by REC1 (0.830) and REC5 (0.685), and Seizing Capability, ranging from 0.704 to 0.795. The Sustainable Supply Chain Performance items had a little wider range, 0.563 to 0.766, but were still within acceptable limits. The loading pattern indicates that each item has made a significant contribution to the intended construct. No item has performed below the cut-off that would warrant its removal or re-specification.

Table 8. Standardized Factor Loadings of Measurement Items

Constructs	Item	Standardised
SEN	SEN1	0.813
	SEN2	0.768
	SEN3	0.744
	SEN4	0.737
	SEN5	0.689
SEZ	SEZ1	0.795
	SEZ2	0.741
	SEZ3	0.730
	SEZ4	0.704
	SEZ5	0.713
REC	REC1	0.830
	REC2	0.794
	REC3	0.775
	REC4	0.690
	REC5	0.685
SSCP	SSCP1	0.766
	SSCP2	0.731
	SSCP3	0.711
	SSCP4	0.650
	SSCP5	0.563

Note. All factor loadings exceeded the minimum acceptable threshold of 0.50 and were statistically significant at p < .001.
Source: Authors' Field Data (2026).

The conceptual path diagram in Figure 1 shows three direct, positive paths from DCV micro-foundations to SSCP, with Sensing having the strongest influence, followed by Seizing and Reconfiguring. It offers a clear visual summary complementing AMOS diagrams.

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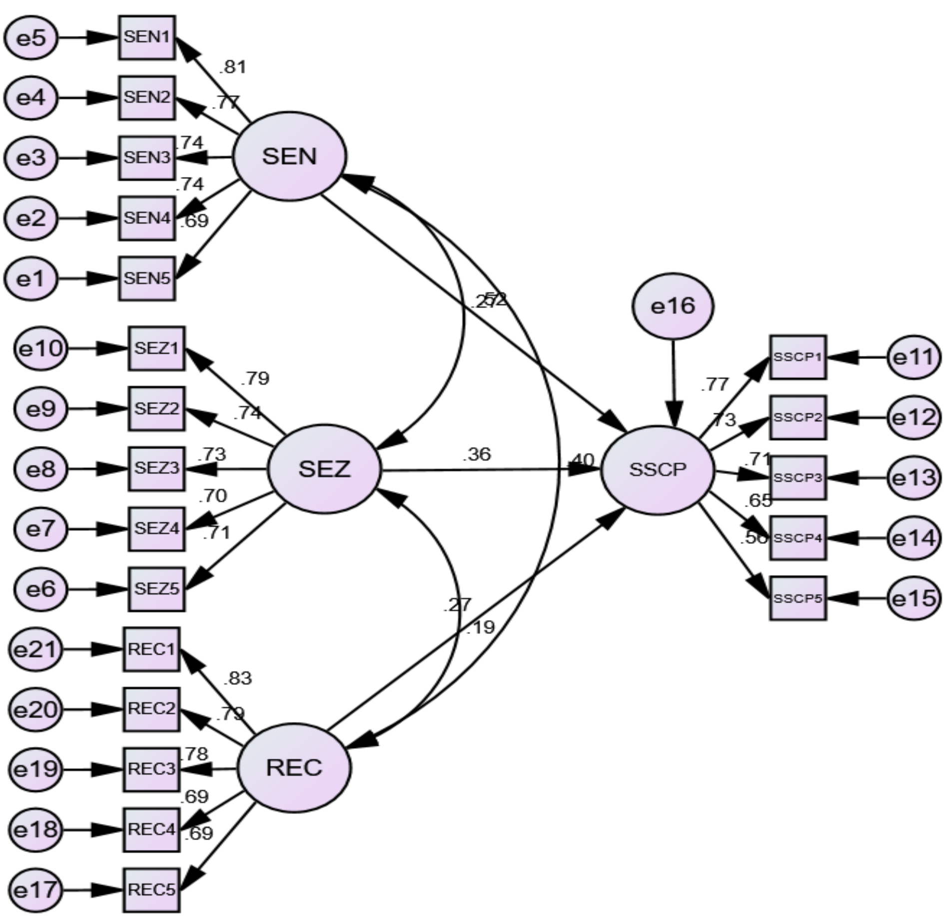

Figure 1. Standardised SEM AMOS Diagram

Figure 2 presents the unstandardised SEM AMOS diagram of the final structural model. While Figure 1 illustrates the standardised relationships among the latent constructs, Figure 2 presents the corresponding unstandardised parameter estimates from AMOS.

Discussion

Sensing Capability as the Primary Driver of Sustainable Supply Chain Performance

The finding that sensing capability had the largest direct effect on SSCP (β=0.521) is less counterintuitive than it might first appear on reflection. In a sector where the most important sustainability choices -- what technologies to adopt, what regulatory routes to prepare for, what supplier relationships to reform -- are made on the basis of environmental intelligence, not just the availability of capital, the quality of a firm's scanning routines generally dictates the quality of every subsequent strategic choice. Firms that proactively observe carbon regulation, adhere to international best practice in clinker substitution and systematically engage with stakeholder expectations develop an anticipatory advantage which feeds directly into more effective supply chain sustainability decisions.

This finding is supported by Essuman et al. (2026) who found that sensing-type capabilities were the main determinant of corporate environmental performance in Ghanaian manufacturing firms, with the effect occurring through both direct and capability-mediated routes. The context is particularly instructive here as Ghana and Nigeria share structural features including regulatory volatility, infrastructure constraints and exposure to international carbon market pressures which give added strategic value to environmental intelligence. Atieh and Abushaega (2025) add another layer, showing that green innovation capacity, which is in part a by-product of environmental scanning quality, reliably mediates the path from sensing to supply chain sustainability performance.

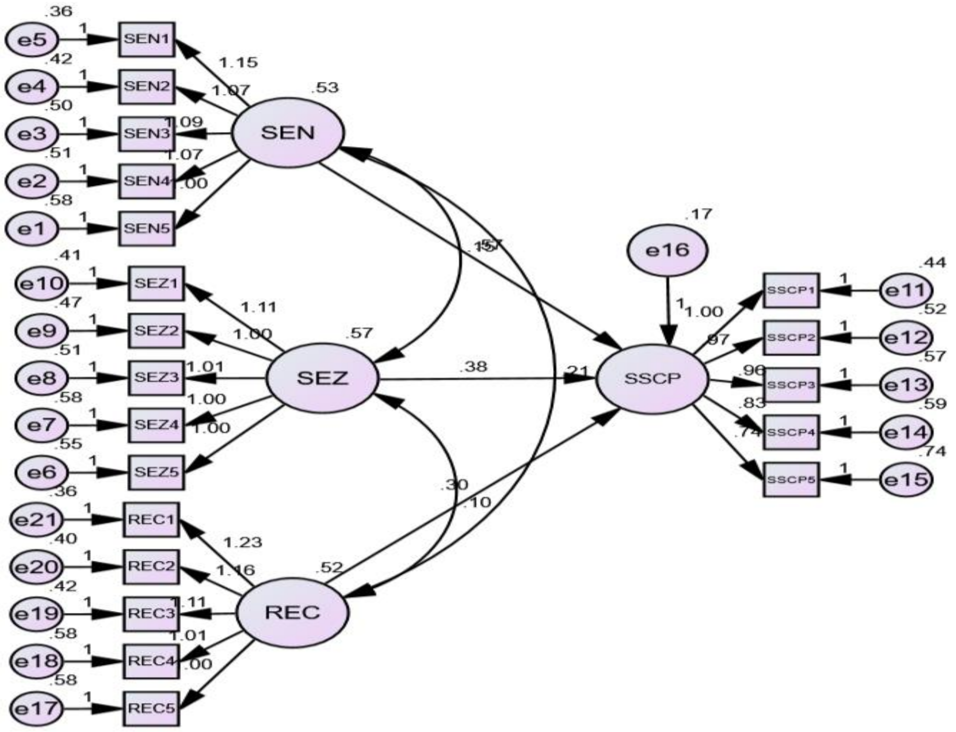

Figure 2. Unstandardised SEM AMOS Diagram

The literature available offers counter-evidence which usefully qualifies this finding. Elnadi et al. (2026) found no significant direct effect of sensing-related capabilities, operationalised through digital transformation readiness, on SSCP without adequate supply chain capabilities. This suggests that the sensing-performance relationship may be contingent on complementary organisational assets that are not uniformly present across Nigerian cement producers. Given that the present study was limited to sampling from the three largest firms that are multinationally affiliated, baseline sensing infrastructure may be higher in this sample than it is in the broader population of Nigerian producers. Similarly, Nguyen et al. (2026) found that the direct effect of environmental scanning on supply chain reconfiguration outcomes was limited where institutional quality was low, raising the possibility that the strength of the sensing-SSCP relationship identified here is partly a product of the institutional context that multinational affiliation creates, rather than a pattern generalizable to all firms in the sector.

Seizing Capability and the Translation of Awareness into Action

The strong positive impact of seizing capability on SSCP (β = 0.361), although less than sensing in this model, confirms the importance of resource mobilisation as a material driver of supply chain sustainability in Nigerian cement manufacturing. The result perhaps represents the most practically consequential insight the study provides: environmental awareness without

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the organisational capacity to act on it is strategically inert. Firms that recognize the need to invest green but lack the capacity to commit capital, attract talent to manage alternative-fuel systems, or restructure supplier relationships to purchase lower-emission inputs do not gain a performance advantage from monitoring alone.

Direct supporting evidence comes in the form of Al Mamun et al. (2025) who find that the ability to align resource deployment with green supply chain goals is one of the strongest predictors of sustainable performance in their multi-country sample, with effects robust to differences in income level and regulatory stringency across contexts. This finding is supported by AlSheyadi et al. (2025), who showed that green dynamic capabilities, operationalized through the allocation of resources to zero-waste and green innovative supply chain practices, resulted in a significant improvement in the sustainable performance of manufacturing firms. Shaban et al. (2024) go a step further by demonstrating that green innovation, which involves resource commitment, consistently mediates the path from dynamic capabilities, including seizing, to sustainable development results.

Literature counter-evidence gives useful qualifications. Mohsin et al. (2025) found that the highest performance effects of resource deployment capability were realized when combined with processes that build resilience, suggesting that seizing may be less effective than embedded seizing in a broader system of dynamic capabilities. de Resende Ribeiro and Neto (2024), specifically in the Brazilian cement sector, find that green capability deployment generated its largest performance gains when it was preceded by green innovation processes rather than as a standalone resource commitment, suggesting that the quality of what resources are invested in matters as much as the scale of the investment itself.

Reconfiguring Capability and the Institutionalisation of Green Practice

The direct effect of reconfiguration capability on SSCP is significant, but smaller in comparison ($\beta = 0.269$). Theoretically, this can be interpreted as a sequential contingency within the DCV framework. When sensing has identified what to change and seizing has provided the means to do so, reconfiguring accounts for the largest share of performance. Organisational restructuring is not a direction or funding without those conditions, first. This relatively lower coefficient magnitude for reconfiguring compared to sensing and seizing may therefore indicate not the lesser importance of reconfiguring capability per se, but rather that it is more dependent than sensing or seizing alone on the other two microfoundations being operative.

The most directly applicable supporting evidence comes from Addo and Ackah (2025) who showed that dynamic supply chain capabilities focused on structural reconfiguration were significant predictors of adoption and performance of sustainable supply chain management practices in their Ghanaian study. The effects were strongest in firms that had already implemented environmental monitoring routines compatible with sensing capability. Similarly, AlSheyadi et al. (2025) found that green dynamic capabilities, such as process reconfiguration, enhance sustainable performance via supply chain restructuring, and the pathway works through both direct and innovation-mediated routes. Nguyen et al. (2026) make a contribution by using a multi-criteria decision-making lens to show the joint effect of supply chain reconfiguration and dynamic capabilities on ESG-related supply chain performance. The effect of reconfiguring capability is magnified by the quality of sensing and resource mobilisation antecedent to it.

Findings from the broader literature muddy this picture. Haryanti et al. (2025) found that measures of structural agility and resilience, which conceptually overlap with reconfiguring capability, had weaker financial performance effects than expected in firms operating under highly volatile input-cost conditions. The performance dividend of reconfiguring may be contingent on a degree of operational stability that Nigerian cement producers, facing persistent energy and logistics cost pressures, may not always have. Kamal et al. (2026) showed that restructuring-oriented capabilities frequently face institutional constraints in emerging economies, like labour market rigidities and infrastructure deficits, which hinder the extent to which firms can reorganize their supply chain operations even when the strategic rationale is clear.

Conclusion

This study tested three hypotheses from the Dynamic Capabilities View, investigating if sensing, seizing and reconfiguring capabilities had significant positive direct impacts on sustainable supply chain performance in the Nigerian cement sector. Using data from 385 managers from the three dominant Nigerian cement producers, the three hypotheses were tested using SEM with CFA in IBM SPSS AMOS version 23 and found strong support for all three hypotheses. Results The measurement model had good psychometric properties and excellent fit on nine indices, a result which was discussed and contextualised in the Results section above. All three structural paths were positive, statistically significant, and robust to bootstrap resampling.

Sensing capability was the most important predictor of SSCP, followed by seizing and reconfiguring. The pattern of results is theoretically consistent within the DCV framework, and supports the conclusion that in this context the ability to generate accurate and timely environmental intelligence contributes more to sustainable supply chain outcomes than the capacity to mobilise resources or restructure operations in isolation, although all three capabilities matter independently. In addition, the study shows that the DCV has a strong explanatory power in Sub-Saharan African heavy manufacturing, a context in which its applicability has been widely assumed but seldom directly investigated. Moreover, the differential path coefficients and the low correlation between the constructs in several pairs offer empirical evidence for the distinctiveness of these three micro-foundations. This challenges the common practice of conceptualizing the dynamic capabilities as a unidimensional composite and supports a disaggregated measurement in future studies.

These results have implications for both the firm and policy levels. Nigerian cement producers should consider creating dedicated environmental intelligence functions that systematically track regulatory developments, technological change and stakeholder expectations and report their output directly to the executive leadership so that sensing activities can drive strategic rather than merely operational decisions. Resource mobilisation for green investment should be formalised by structured capital allocation processes, whose investment criteria are linked to the environmental intelligence generated by sensing routines. Operational restructuring for sustainability should be viewed as an ongoing governance function, where the supply chain process is periodically reviewed to identify misalignments between current routines and environmental objectives. Evidence at the policy level that all three capability dimensions independently predict SSCP speaks for industrial policy frameworks that go beyond regulatory compliance to actively build the sensing, seizing and reconfiguring capacities on which sustainable supply chain performance ultimately rests.

These recommendations are pertinent not only to Nigeria but to any emerging economy where cement and related heavy industries are under increasing pressure to conform to global sustainability commitments while being constrained by resource and institutional limitations. The theoretical framework and empirical approach adopted here offers a replicable model for researchers in Asian and other developing-economy contexts seeking to study the organisational antecedents of green supply chain transformation in capital-intensive sectors. The key ways to extend this work, as described above, include longitudinal and multi-industry

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designs, triangulation with objective performance data, and explicit tests of demographic and organisational moderators of the capability-performance relationships identified here.

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