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Digital Supply Chain Management and Digital Inclusion in Food & Beverage Companies in Nigeria: The Mediating Role of Sustainability

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Abstract:- Digital Supply Chain Management (DSCM) is increasingly viewed as a catalyst for organizational transformation, yet its role in advancing digital inclusion remains underexplored, particularly in emerging economies. Prior research has largely focused on the efficiency and technological gains of DSCM, overlooking the extent to which sustainability may serve as a bridge between digitalization and inclusive outcomes. This study addresses that gap by investigating the mediating effects of economic, social, and environmental sustainability on the relationship between DSCM and digital inclusion in Nigeria's food and beverage sector. Adopting a cross-sectional survey design, data were collected from 256 staff at multiple organizational levels across food and beverage companies in Nigeria. Using PROCESS Macro (Model 4, parallel mediation), both direct and indirect pathways were tested. The findings reveal that DSCM positively influences all three dimensions of sustainability, each of which significantly predicts digital inclusion. Mediation analysis demonstrates that DSCM's impact on inclusion operates entirely through sustainability, with economic sustainability exerting the strongest influence, followed by social and environmental dimensions. This study concludes that digital transformation on its own is insufficient to foster inclusive outcomes unless complemented by sustainable practices. The study recommends that managers should align digitalization strategies with fair procurement, timely payments, digital literacy programs, and environmentally responsible initiatives. Policymakers are also encouraged to design enabling policies and incentives that support the integration of sustainability within digital supply chain practices.

Keywords*: Digital Supply Chain Management, Digital Inclusion, Sustainability, Food and Beverage companies, Nigeria.*

1. Introduction

The Food and Beverage (F&B) industry in Nigeria is central to economic growth, job creation, and consumer welfare. However, the sector is constrained by weak supply chain networks, structural inefficiencies, and mounting sustainability challenges linked to resource scarcity, regulatory uncertainty / regulatory frameworks for operational policies, standards and guidelines, and evolving customer expectations (Ekpudu et al., 2025). The COVID-19 pandemic further exposed these vulnerabilities, disrupting supply chains and reducing resilience (Ivanov et al., 2023). Addressing these challenges requires innovative approaches such as DSCM, which enhances transparency, adaptability, and efficiency (Esangbedo et al., 2024; AlMulhim, 2021).

DSCM incorporates advanced technologies, including Artificial Intelligence (AI), Blockchain, Big Data Analytics, and the Internet of Things (IoT), to improve procurement, logistics, and production activities while strengthening responsiveness to disruptions (Dolgui & Ivanov, 2022; Ye et al., 2022). Yet, in emerging

economies, the transformative potential of DSCM is contingent upon digital inclusion, defined as equitable access to digital infrastructure, literacy, and opportunities (Ekbia, 2016; Heeks, 2022). Without digital inclusion, digitalized supply chains risk reinforcing structural inequalities by excluding smallholder farmers, informal distributors, and other marginalized actors who remain vital to Nigeria's F&B industry (Nemer, 2015; Asokan, Smith, & Huq, 2025).

Evidence from China and other emerging markets suggests that integrating digital inclusion with supply chain practices fosters innovation, reshapes consumer behavior, and drives sustainable competitiveness (Ye & Yue, 2024; Bu & Xie, 2024). In contrast, Africa lags behind due to inadequate infrastructure, limited digital literacy, and fragmented policy environments (Ahmed, 2024). At the same time, sustainability has become a critical pathway through which DSCM and digital inclusion affect long-term performance. Embedding environmental and social practices within supply chains not only enhances competitiveness but also builds resilience and stakeholder trust (Esangbedo et al., 2024; Obiri-Yeboah, Amoatey, Ottou, & Yirenkyi-Fianko, 2025). For Nigerian firms which face the dual pressures of global sustainability agendas and local socio-economic realities, adopting sustainability-oriented supply chains is essential for reconciling profitability with ecological and social responsibility (Opaleye, Opaleye, Adelugba, & Babatunde, 2025).

Despite growing scholarship on DSCM and sustainability (Esangbedo et al., 2024; Ivanov, 2021), limited empirical research examines the role of digital inclusion as a central mechanism in emerging markets. This gap is particularly evident in Nigeria's F&B industry, where smallholder farmers and informal distributors play critical roles yet remain digitally disadvantaged. Therefore, this study investigates how DSCM and digital inclusion influence organizational outcomes in Nigeria's F&B sector, with sustainability as a mediating factor.

2. Theoretical Framework

2.1 Theoretical Background

This study draws on the integration of the Resource-Based View (RBV) and stakeholder theory to provide a deeper understanding of how DSCM can foster digital inclusion through the mediating role of sustainability, economic, social, and environmental, in Nigeria's F&B industry. The RBV explains how firms gain and sustain competitive advantage by developing and deploying resources that are Valuable, Rare, Inimitable, and Non-substitutable (VRIN) (Wernerfelt, 1984; Barney, 2001; Barney & Arikan, 2005). Within the context of DSCM, resources such as artificial intelligence, blockchain, big data analytics, and digital platforms serve as strategic assets. These tools not only enhance transparency and efficiency but also create opportunities for greater digital inclusion across supply chains (David-West et al., 2018; Kamboj & Rana, 2023).

Recent studies show that digital technologies embedded into supply chain systems do more than improve efficiency, they also broaden participation by enabling small firms, distributors, and suppliers to engage more actively (Bu & Xie, 2024; Lu et al., 2024). RBV further suggests that capabilities such as supply chain finance innovations (Wang et al., 2023) and trust in digital platforms (Han et al., 2024b) can strengthen competitive positioning and sustainability outcomes. Importantly, RBV emphasizes that the real value of DSCM lies not in simply acquiring digital technologies but in a firm's ability to integrate, adapt, and apply them effectively across its operations (Wu et al., 2006; Lockett et al., 2009; Shahadat et al., 2023; Willie, 2025). For example, blockchain

for traceability, digital procurement platforms, and online logistics systems can give Nigerian F&B firms an edge when used to ensure product safety, minimize waste, and include SMEs and farmers in supply chains (Ali & Salman, 2025; Han et al., 2024a).

While RBV focuses on the internal resources of a firm, stakeholder theory complements it by directing attention to the firm's responsibilities and relationships with its broader network of stakeholders (Freeman, 1984; Hörisch, Schaltegger & Freeman, 2020). The theory stresses that a company's legitimacy and long-term success depend on its ability to meet the needs of employees, suppliers, customers, regulators, and local communities (Freeman, 1984; Lépineux, 2005; Mitchell et al., 2021). In Nigeria's F&B sector, the role of stakeholders cannot be overlooked, particularly given the country's unequal access to digital infrastructure. Researchers argue that digital supply chain innovation must therefore balance profitability with collaboration, trust, and value co-creation (Al-Omoush et al., 2023; Paula et al., 2020; Hörisch et al., 2020). Moreover, engaging stakeholders ensures that sustainability initiatives reflect economic, social, and environmental concerns while aligning with national and global development goals (Govardhan et al., 2025; Aman & Al Mubarak, 2024).

Digital inclusion is especially relevant here. Tools such as mobile payment systems, blockchain-enabled financing, and e-supply chain platforms can expand access to markets and resources for marginalized suppliers and SMEs (Mhlanga & Moloi, 2020; Zaman, Khan, & Kusi-Sarpong, 2024). By meeting stakeholder expectations for fairness, transparency, and access, companies not only enhance their legitimacy but also generate shared value (Lépineux, 2005; Chen & Yu, 2024).

Integrating RBV and stakeholder theory therefore offers a more holistic foundation for this study. RBV highlights how internal resources and digital capabilities drive competitiveness and inclusion, while stakeholder theory explains why these strategies must also align with the needs and expectations of diverse stakeholders. The integration of the two perspectives helps explain not only how firms use digital tools to improve performance, but also why collaboration, equity, and sustainability are essential for embedding digital inclusion across F&B supply chains (Mitchell & Cohen, 2006; Shibin et al., 2020).

In a nutshell, RBV captures the internal drivers of digital transformation, whereas stakeholder theory situates these drivers within a wider ecosystem of interdependent relationships. Together, the two theories suggest that Nigerian F&B firms can achieve sustainable supply chain performance when they build and deploy unique digital resources and ensure that these resources advance digital inclusion, stakeholder engagement, and long-term sustainability.

2.2 Conceptual Framework and Hypothesis Development

2.2.1 Conceptual Framework

DSCM, the integration of technologies such as IoT, Blockchain, Digital platforms, Enterprise Resource Planning (ERP) or cloud systems, and e-procurement, has redefined how multinational F&B firms coordinate suppliers, financial flows, traceability, and market access. As supply chains undergo digital transformation, DSCM has become a strategic driver of sustainability and stakeholder value creation (Dwivedi & Paul, 2022; Stroumpoulis & Kopanaki, 2022). Through the deployment of big data analytics, artificial intelligence, digital platforms, and blockchain, DSCM enhances visibility, responsiveness, collaboration, and eco-innovation, which are critical to

advancing the triple bottom line of economic, social, and environmental sustainability (Seuring et al., 2008; Rajeev et al., 2017).

In Nigeria's F&B sector, where infrastructural deficiencies and digital divides remain prevalent, DSCM can act as a catalyst for digital inclusion by expanding access to payment platforms, supply chain data, and consumer services. Digital inclusion in this context goes beyond technology adoption. It entails fostering accessibility, participation, and fairness in the distribution of digital opportunities (Gurzawska, 2020; Nandi et al., 2021; Rosca et al., 2022; Enyejo et al., 2024). However, the linkage between DSCM and digital inclusion is complex. Studies suggest that sustainability mediates this relationship, as practices such as green logistics, circular economy models, and social responsibility provide both legitimacy and operational frameworks that convert digital investments into inclusive outcomes (Mubarik & Khan, 2024; Zaid, Jaaron & Talib, 2025). Put differently, DSCM contributes most effectively to digital inclusion when embedded within socially responsible, environmentally sound, and economically viable business models (Junge & Straube, 2020; Tseng et al., 2021).

The global turn toward sustainability further compels firms to align their economic, social, and environmental priorities with digital transformation and inclusive growth (Al Hawaj & Buallay, 2022; Van Zanten & Van Tulder, 2021). For Nigerian F&B firms, economic sustainability involves efficient resource utilization, cost optimization, and investment in digital infrastructures that expand access to markets and financial services (Ozili, 2022; Sun & Tang, 2022; Gao, 2023; Ozili, Ademiju, & Rachid, 2023). Social sustainability emphasizes equity, workforce empowerment, and community development; initiatives such as digital literacy programs, inclusive hiring, and outreach efforts to help reduce digital divides and enable broader participation in digital ecosystems (Akosile et al., 2025; Nwobu, 2025). Environmental sustainability, on the other hand, encompasses waste reduction, energy efficiency, and green technology adoption. Research shows that environmentally responsible practices often encourage the uptake of blockchain, IoT, and other digital solutions, thereby ensuring food safety, traceability, transparency, and inclusivity across supply chains (Khan et al., 2022; Kshetri, 2023a; Ozili, 2023; Shabir, 2024).

Collectively, the conceptual framework positions sustainability, economic, social, and environmental, as a crucial enabler of digital inclusion in the Nigerian F&B industry. By aligning with the UN Sustainable Development Goals (SDGs), particularly those centered on innovation, responsible consumption, and inclusive growth (Adams et al., 2023; Prasanna et al., 2024), sustainability provides the foundation for firms to transform digital capabilities into meaningful inclusion across stakeholders.

2.3 Hypothesis Development

2.3.1 DSCM and Digital Inclusion

Empirical studies increasingly demonstrate the impact of DSCM on inclusivity outcomes across global supply chains. For instance, blockchain-enabled traceability and fintech-driven supply-chain finance have been shown to enhance trust, improve access to credit, and integrate small suppliers into formal value chains (Han, Ulhøi, & Song, 2024; Yu et al., 2024). Similarly, evidence from emerging markets highlights that DSCM platforms expand market reach, reduce transaction costs, and strengthen participation of SMEs and smallholder producers in digitally mediated supply chains (Fang & Zhang, 2021; Chauhan et al., 2022; Bu & Xie, 2024). DSCM is also a key driver of transformation in industries, particularly in emerging economies where firms are seeking to integrate

advanced technologies for efficiency, inclusivity, and competitiveness (Kache & Seuring, 2017; Frederico et al., 2020). By leveraging technologies such as big data analytics, cloud systems, and digital platforms, DSCM can enhance connectivity and improve participation of stakeholders across the value chain (Ivanov & Dolgui, 2020).

Digital technologies and data-driven capabilities are strategic resources that generate competitive advantage when rare, firm-specific, and well-orchestrated (Wernerfelt, 1984; Barney, 2001; Kamboj & Rana, 2023). Yet, in supply chains, digital transformation goes beyond technology, it requires engaging suppliers, regulators, communities, and customers to create shared value rather than reinforce exclusion (Freeman, 1984; Mitchell et al., 2015; Miles, 2017). DSCM, enabled by IoT, blockchain, fintech, and cloud systems, strengthens visibility, collaboration, and traceability across networks (Udeh et al., 2024; Wamba & Queiroz, 2020; Chauhan et al., 2022), a capability especially critical for Nigerian F&B firms struggling with infrastructural gaps and digital divides. While DSCM is linked to operational resilience and efficiency (Han, Ulhøi, & Song, 2024), little is known about its role in advancing digital inclusion, equitable access, participation, and use of digital tools, particularly in emerging markets (Nandi et al., 2021; Rosca et al., 2022; Enyejo et al., 2024).

In the Nigerian context, recent studies confirm that digital platforms and e-procurement systems improve supplier participation, facilitate mobile payments, and create more transparent and equitable buyer–supplier relationships (Enyejo et al., 2024; Udeh et al., 2024). These findings align with broader evidence that DSCM adoption enhances inclusion by lowering entry barriers and providing marginalized actors with access to real-time information, markets, and financing options (Rosca et al., 2022; Mhlanga, 2023). However, much of the existing empirical work remains fragmented, with limited direct testing of the DSCM-digital inclusion nexus in Sub-Saharan Africa, particularly within the F&B sector. This study, therefore, argues that DSCM adoption in Nigerian F&B companies is likely to strengthen digital inclusion by enabling equitable access and participation across supply-chain partners and stakeholders. Accordingly, the following hypothesis is proposed:

H1. DSCM is positively associated with digital inclusion.

2.3.2 DSCM and Sustainability

Empirical studies increasingly show that DSCM plays a critical role in strengthening sustainability performance across economic, social, and environmental dimensions. Beyond operational benefits, DSCM has emerged as a critical driver of sustainability across economic, social, and environmental dimensions (Junge & Straube, 2020; Nandi et al., 2021; Dwivedi & Paul, 2022). Economically, digital platforms and analytics reduce transaction costs, optimize resource allocation, and enhance financial stability by fostering collaboration and operational resilience (Zaid et al., 2025; Meng et al., 2025; Hasanova & Romanovs, 2020; Ma et al., 2022). For multinational companies, these capabilities provide agility in the face of disruptions and safeguard competitive advantage (Shen & Karia, 2024). Beyond efficiency, DSCM also advances social sustainability through transparency and inclusion. Technologies such as blockchain and data monitoring improve accountability in labor practices, ensure compliance with standards, and promote equitable treatment of suppliers (Saberi et al., 2019; Nureen et al., 2023). By embedding fairness and collaboration across networks, firms foster shared value creation and broaden participation (Srinivasan & Eden, 2021; Junge & Straube, 2020; Rosca et al., 2022).

Environmental outcomes are also strengthened when DSCM is leveraged to promote circularity and reduce ecological footprints. Predictive analytics, IoT, and digital twins optimize logistics and production efficiency, lowering emissions and energy use (Enyejo et al., 2024; Tsolakis et al., 2023), while blockchain and AI-driven insights support traceability and waste reduction (Nandi et al., 2021). Moreover, ESG-oriented investments and certifications tied to digital systems provide access to premium markets and improve firms' environmental legitimacy (Kshetri, 2023b; Lanzalonga et al., 2025). Yet, despite these benefits, most evidence is drawn from developed economies, with little known about how DSCM drives triple-bottom-line outcomes in emerging markets such as Nigeria's F&B sector, where infrastructural inefficiencies and digital divides are persistent. This study advances the following hypotheses:

H2a: DSCM is positively associated with the economic and governance sustainability.
H2b: DSCM is positively associated with the social sustainability.
H2c: DSCM is positively associated with the environmental sustainability.

2.3.3 Sustainability and Digital Inclusion

In Nigeria's F&B industry, sustainability and digital inclusion are increasingly intertwined as firms face pressure to align with the SDGs while pursuing digital transformation. Sustainability, spanning social, economic, and environmental dimensions, directly shapes firms' capacity and incentives to adopt digital technologies. Social sustainability, through employee training, fair labor practices, and community engagement, builds human capital and digital literacy, enabling broader participation in digital supply-chain integration and customer engagement (Malik et al., 2022; Mtapuri, Camilleri, & Dłużewska, 2022). Economic sustainability, reflected in financial resilience and inclusive value creation, provides the resources necessary to invest in digital infrastructure and expand access (Ozili, 2022; Nwobu, 2025). Similarly, environmental sustainability, through energy efficiency, waste reduction, and green technologies, generates demand for digital tools to monitor, trace, and report environmental performance (Kshetri, 2023b; Costa et al., 2023). Together, these pillars make sustainability not only a normative responsibility but also a catalyst for digital inclusion in resource-constrained contexts.

Theoretically, stakeholder theory highlights how consumer demands for traceability, regulatory compliance, and investor expectations for ESG disclosure push firms to adopt sustainability practices that rely on digital systems (Van Zanten & Van Tulder, 2021; Bouguerra et al., 2023). The RBV further suggests that sustainability-oriented investments in green technologies, training, and responsible processes develop unique capabilities that strengthen digital readiness and competitiveness (Mattera & Gava, 2022). Empirical studies show that eco-innovation, transparent sourcing, and responsible supply chains foster trust and accelerate the uptake of digital platforms (Rosca et al., 2022; Gurzawska, 2020), while workforce training and inclusion initiatives broaden digital access to marginalized stakeholders (Srinivasan & Eden, 2021; Li et al., 2023). Financial resilience enables digital investments (Al Hawaj & Buallay, 2022; Costa et al., 2023), and environmental reporting obligations create demand for monitoring technologies (Kshetri, 2023b; Sandberg et al., 2023). Taken together, these arguments support the proposition that sustainability practices act as strategic drivers of digital inclusion in Nigerian F&B firms. Therefore, this study hypothesizes that:

H3a: Economic and Governance sustainability is positively associated with the digital inclusion.

H3b: Social sustainability has a significant positive effect on digital inclusion.

H3c: Environmental sustainability is positively associated with the digital inclusion.

2.3.4 Moderating role of Sustainability

DSCM has emerged as a transformative force in emerging economies, particularly in Nigeria's F&B industry, where firms are under pressure to improve efficiency, competitiveness, and inclusivity (Kache & Seuring, 2017; Frederico et al., 2020). Through IoT, blockchain, e-procurement, supply-chain finance platforms, and digital payments, DSCM reduces transaction costs, enhances transparency, and generates digital records that enable suppliers, distributors, and smallholders to access formal financial services (Lu, Jiang, & Wang et al., 2024; David-West, Iheanachor, & Kelikume, 2018; Fang & Zhang, 2021). Yet, while these technologies directly expand access, evidence suggests that sustainability considerations, economic, social, and environmental, are critical in determining whether such gains translate into genuine and equitable financial inclusion (Queiroz & Wamba, 2019; Sarkis, 2020). Without embedding sustainability, digital transformation risks amplifying exclusion and inequality, rather than bridging divides (Gurzawska, 2020; Tseng et al., 2022).

Sustainability enhances the inclusivity potential of DSCM by reinforcing economic resilience, advancing social equity, and promoting environmental responsibility. Economic sustainability, supported by cost optimization, stable procurement practices, and resource efficiency, strengthens suppliers' market participation and lowers barriers to finance (Dubey et al., 2019; Centobelli et al., 2020; World Bank, 2023). Social sustainability, through capacity building, equitable participation, and transparency, expands digital literacy and empowers marginalized stakeholders, creating more equitable access to digital platforms (Carter et al., 2019; Mhlanga, 2020; UNDP, 2023). Environmental sustainability further encourages digital adoption by requiring traceability, monitoring, and reporting systems that align small-scale producers with global sustainability standards (Ahi & Searcy, 2015; Queiroz et al., 2022). Empirical studies reinforce this argument: supplier capacity building has been shown to increase adoption of digital payments (Fang & Zhang, 2021; Malik et al., 2022), ESG disclosure enhances lender confidence (Nandi et al., 2021; Kshetri, 2023b), and stable procurement practices reduce risks for supply-chain finance (Zaid, Farooqi, & Azmi, 2025).

From a theoretical perspective, the RBV suggests that sustainability practices, process redesign, certifications, and inclusive governance, act as complementary resources that enhance the credibility and value of DSCM outputs, making them more usable by financial providers and supply-chain partners (Barney, 2001; Ma, Shi, & Kang, 2022). Stakeholder theory reinforces this by highlighting how sustainability signals legitimacy, trust, and fairness, thereby lowering relational barriers to financial onboarding (Mitchell et al., 2015; Rosca et al., 2022). Together, these insights suggest that sustainability does not merely accompany DSCM adoption but actively strengthens its outcomes, serving as a moderator that amplifies the positive effect of DSCM on financial inclusion. Accordingly, this study proposes that:

H4a: Economic sustainability mediates the relationship between DSCM and digital inclusion.

H4b: Social sustainability mediates the relationship between DSCM and digital inclusion.

H4c: Environmental sustainability mediates the relationship between DSCM and digital inclusion.

Figure 1. Conceptual Framework.

3. Methodology

3.1 Sample and Measures

This study adopts a quantitative research design with a cross-sectional survey approach. A structured questionnaire was used to collect data from respondents across selected multinational and large indigenous F&B companies in Nigeria. This approach is suitable as it allows for hypothesis testing and statistical validation of relationships between DSCM, sustainability (economic, social, environmental), and digital inclusion. The study's population encompasses professionals holding positions as managers, officers, and staff. These individuals are drawn from key departments within F&B companies operating in Nigeria. The departments specifically included in the study's scope are: supply chain, procurement, IT/digital transformation, finance, and sustainability/corporate social responsibility (CSR). The companies participating in this research are segmented into two primary categories: multinational corporations and significant indigenous enterprises. The multinational firms that form part of this study cohort include Nigeria, Coca-Cola Nigeria, Nigerian Breweries, FrieslandCampina WAMCO, 7Up/PepsiCo, and CHI Limited. Complementing these are the large indigenous firms, which consist of Dangote Sugar, and Rite Foods. These companies were selected because they operate structured supply chains, have adopted digital transformation practices, engage in sustainability initiatives, and promote financial inclusion through supplier/vendor programs.

A sample size of 256 respondents was used. This sample is considered sufficient to provide statistical power for testing the research hypotheses and ensuring generalizability of the findings. A purposive sampling technique was adopted to ensure that only respondents with relevant knowledge and involvement in digital supply chain management, sustainability practices, and financial inclusion were selected. The questionnaire employed a 5-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree. Items were adapted from validated scales in prior research to ensure content validity and reliability (Lanzalonga et al., 2025; Adams et al., 2023; Gazzola et al., 2024; Malik et al., 2022; Camilleri, 2025; Ozili, 2023; Shabir, 2024).

The measurement of DSCM adoption contained five items: (1) the company uses digital technologies such as AI, ERP, and IoT to integrate supply chain activities; (2) the company relies on digital platforms to improve the

accuracy of demand forecasting; (3) the company employs digital tools to enhance information sharing with suppliers and partners; (4) the company applies digital solutions to reduce delays and errors in procurement and logistics processes; and (5) the company leverages digital supply chain technologies to improve overall operational efficiency (Lanzalonga et al., 2025; Adams et al., 2023; Gazzola et al., 2024; Malik et al., 2022).

Similarly, economic sustainability was measured using four items: (1) the company invests in practices that improve long-term financial performance; (2) the company reduces transaction costs and optimizes resource allocation; (3) the company ensures stable procurement processes and timely payments to strengthen supplier relationships; and (4) the company adopts digital and financial innovations that enhance competitiveness and value creation (Zaid et al., 2025; Shen & Karia, 2024; Ma et al., 2022). Social sustainability was captured through four items: (1) the company promotes equity in supply chain relationships; (2) the company invests in workforce training, safety, and digital capacity building; (3) the company ensures compliance with labor standards while supporting community development initiatives; and (4) the company fosters collaboration and shared value creation with suppliers, employees, and other stakeholders (Gurzawska, 2020; Srinivasan & Eden, 2021; Rosca et al., 2022). Environmental sustainability was measured through four items: (1) the company reduces waste and improves efficiency in resource use; (2) the company implements practices to minimize carbon emissions and energy consumption; (3) the company integrates green technologies and eco-friendly processes into production and logistics; and (4) the company supports circular economy practices such as recycling, reuse, and traceability of environmental initiatives (Dwivedi & Paul, 2022; Enyejo et al., 2024).

Finally, digital inclusion was measured with four items: (1) the company uses digital platforms to expand access to financial and operational resources for suppliers; (2) the company provides digital tools and training to enable marginalized or smaller actors to participate effectively; (3) the company fosters transparency and accountability through digital traceability and reporting systems; and (4) the company ensures that all supply chain partners benefit equitably from digital transformation initiatives (David-West, Iheanachor, & Kelikume, 2018; Fang & Zhang, 2021; Nureen et al., 2023).

3.2 Sample Sociodemographic Characteristics.

Table 1 summarizes the socio-demographic characteristics of the 256 respondents. The gender distribution was relatively balanced, with males comprising 53.2% and females 46.8%. In terms of age, the majority were mid-career professionals, dominated by those aged 35-44 years (34.4%) and 25-34 years (29.3%), followed by respondents in the 45-54 years bracket (18.4%), while younger (18-24 years, 11.3%) and older participants (55 years and above, 6.6%) were less represented. The educational profile indicated a highly qualified sample, with 44.9% holding a bachelor's degree or higher national diploma and 32.4% possessing a master's qualification, alongside smaller proportions with doctoral degrees (5.9%), OND/NCE (10.2%), or WAEC/NECO (5.1%). Regarding occupational status, low-level managers (42.6%) and middle-level managers (34.0%) constituted the majority, while officers (18.0%) and top managers (5.5%) were fewer. Departmental representation was diverse, with procurement (24.2%) and administration (22.7%) most prevalent, followed by IT (21.9%), sustainability/CSR (16.8%), and finance (14.5%). Tenure distribution also reflected a balanced workforce, with

32.4% having 10-20 years in their firms, 26.6% between 5-9 years, 21.1% less than 5 years, and 19.9% over 20 years, offering perspectives from both relatively new entrants and highly experienced professionals.

Table 1 Socio-demographic Characteristics

Variables	Categories (Labels)	Frequency	Percentage
Gender	Female	108	42.2%
	Male	148	57.8%
	Total	256	100%
Age	18-24 years	29	11.3%
	25-34 years	75	29.3%
	35-44 years	88	34.4%
	45-54 years	47	18.4%
	55 years and above	17	6.6%
	Total	256	100%
Educational Qualification	WAEC/NECO	13	23.4%
	OND/NCE	26	9.0%
	BSc. /HND	115	26.9%
	MSc. /MBA	83	30.3%
	Ph.D.	15	9.5%
	Others	4	1.0%
	Total	256	100%
Occupational position	Top Manager	14	5.5%
	Middle-level Manager	87	34.0%
	Low-level Manager	109	42.6%
	Officer	46	18.0%
	Total	256	100%
Department	Procurement	62	24.2%
	IT	56	21.9%
	Finance	37	14.5%
	Sustainability/CSR	43	16.8%
	Administration	58	22.7%
	Total	256	100%
Number of Years in the Current Firm	Less than 5 years	54	21.1%
	5-9 years	68	26.6%
	10-20 years	83	32.4%
	Above 20 years	51	19.9%
	Total	256	100%

4. Results

4.1 Scale validation

To ensure the reliability of the measurement instrument, Cronbach's alpha coefficients and corrected item-total correlations were examined. A Cronbach Alpha threshold of 0.70 (Saunders et al., 2019) was used as the benchmark for internal consistency. The results as shown in Table 2 indicated that all constructs demonstrated acceptable reliability thresholds above the recommended minimum of 0.70. Digital inclusion showed the highest corrected item-total correlation (.869) with Cronbach's alpha if deleted at .860, while Economic Sustainability (ES), Social Sustainability (SS), and Environmental Sustainability (EnS) also demonstrated strong reliability with corrected item-total correlations of .769, .830, and .800, respectively, and Cronbach's alpha if deleted ranging from .869 to .883. DSCM recorded the lowest corrected item-total correlation (.561) but retained a Cronbach's alpha if deleted of .925, confirming its adequacy. Overall, the results demonstrate that all constructs exhibit satisfactory internal consistency, validating their suitability for further empirical analysis.

Table 2. Reliability of the instrument

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
DI	15.6579	2.898	.869	.860
EnS	15.6607	2.880	.769	.883
SS	15.8004	2.963	.830	.869
ES	15.9250	3.079	.800	.876
DSCM	16.3226	3.337	.561	.925

4.2 Descriptive Statistics

The descriptive statistics in Table 3 summarize the respondents' perceptions of the key constructs in this study. DI recorded the highest mean score (M = 4.18, SD = 0.50), followed closely by EnS (M = 4.18, SD = 0.55). This indicates that respondents strongly agreed that digital access, literacy, and equitable opportunities are being fostered within supply chain activities, while environmental sustainability practices are also highly valued. SS produced a similarly high mean (M = 4.04, SD = 0.50), suggesting that organizations prioritize social considerations such as stakeholder welfare, inclusiveness, and community development. ES recorded a slightly lower mean (M = 3.92, SD = 0.47), though still above the scale midpoint, implying that while firms recognize the importance of long-term economic stability, efforts in this area are less emphasized compared to environmental and social dimensions. DSCM had the lowest mean (M = 3.52, SD = 0.50), showing that although digital technologies are being adopted, their integration across procurement, logistics, and production processes is still moderate and less advanced compared to sustainability and inclusion measures. Overall, the descriptive results suggest that Nigerian F&B firms are making significant strides in advancing digital inclusion and sustainability, but the full-scale adoption of DSCM technologies remains in its early stages.

Table 3. Descriptive Statistics

	Mean	Std. Deviation
DI	4.1837	0.49965
EnS	4.1810	0.55196
SS	4.0413	0.49592
ES	3.9167	0.47182
DSCM	3.5190	0.50475

4.3 Findings and Hypotheses Testing

Table 4 reports the results of the hypotheses testing using Hayes' PROCESS macro (Model 4). The total effect of DSCM on DI was positive and significant ($\beta = 0.49$, $p < 0.001$), indicating initial support for H1. However, once the mediators were introduced, the direct effect of DSCM on DI became statistically insignificant ($\beta = 0.05$, $p = 0.12$), suggesting that the relationship is fully mediated through sustainability dimensions.

For the sustainability pathways, DSCM showed significant positive effects on all three mediators: EnS ($\beta = 0.44$, $p < 0.001$), SS ($\beta = 0.51$, $p < 0.001$), and ES ($\beta = 0.58$, $p < 0.001$). These results support H2a, H2b, and H2c,

confirming that supply chain digitalization enhances sustainability outcomes across the environmental, social, and economic domains.

In turn, each of the sustainability dimensions had a significant effect on digital inclusion. EnS exerted the strongest effect ($\beta = 0.55$, $p < 0.001$), followed by SS ($\beta = 0.24$, $p < 0.001$) and ES ($\beta = 0.13$, $p < 0.01$). Thus, hypotheses H3a, H3b, and H3c are supported, demonstrating that firms that advance sustainability also foster digital access, literacy, and equity.

Mediation analysis confirmed the indirect effects of DSCM on DI through all three sustainability pathways. The total indirect effect was significant ($\beta = 0.44$, BootLLCI = 0.21, BootULCI = 0.65), with specific contributions from EnS ($\beta = 0.24$, BootLLCI = 0.07, BootULCI = 0.40), SS ($\beta = 0.12$, BootLLCI = 0.05, BootULCI = 0.19), and ES ($\beta = 0.08$, BootLLCI = 0.02, BootULCI = 0.14). These results support H4a, H4b, and H4c, confirming that the impact of DSCM on DI is transmitted through the three dimensions of sustainability. Importantly, EnS was the most influential mediator, followed by SS and ES, highlighting the centrality of environmental practices in shaping inclusive digital transformation. Overall, all proposed hypotheses (H1–H4c) were supported, although the direct association between DSCM and DI disappeared once sustainability mediators were included. This suggests that the pathway from digital supply chain management to digital inclusion operates primarily through firms' economic, social, and environmental sustainability initiatives.

Table 4
Hypotheses Testing

Hypotheses	Coefficient (β)	S.E.	t-value	p-value	LLCI	ULCI	Decision
H1: DSCM → DI (total effect)	0.49	0.05	9.07	0.000	0.39	0.60	Supported
H1: DSCM → DI (direct effect)	0.05	0.03	1.55	0.120	-0.01	0.11	Not Supported
H2a: DSCM → EnS	0.44	0.06	6.95	0.000	0.32	0.56	Supported
H2b: DSCM → SS	0.51	0.05	9.68	0.000	0.41	0.62	Supported
H2c: DSCM → ES	0.58	0.05	12.68	0.000	0.49	0.68	Supported
H3a: EnS → DI	0.55	0.03	16.48	0.000	0.49	0.62	Supported
H3b: SS → DI	0.24	0.05	5.22	0.000	0.15	0.32	Supported
H3c: ES → DI	0.13	0.05	2.97	0.003	0.05	0.22	Supported
H4a: DSCM → EnS → DI	0.24	0.08	–	–	0.07	0.40	Supported
H4b: DSCM → SS → DI	0.12	0.04	–	–	0.05	0.19	Supported
H4c: DSCM → ES → DI	0.08	0.03	–	–	0.02	0.14	Supported
Total Indirect Effect (Mediators)	0.44	0.11	–	–	0.21	0.65	Significant

**p < .01.
*p < .05.

4.4 Discussion

The present research is among the first empirical studies to examine the relationship between DSCM, sustainability dimensions (economic, social, and environmental), and digital inclusion in the Nigerian F&B sector. This study extends knowledge at the intersection of supply chain digitalization, sustainability, and inclusion. The findings contribute to sustainability and digital transformation literature by employing an empirical approach that highlights how sustainability acts as a central mechanism through which DSCM drives digital inclusion, with implications for both managerial practice and public policy. The results are elaborated as follows.

First, the results revealed that DSCM has a significant total effect on digital inclusion ($\beta \approx 0.49$, $p < .001$). Yet, once sustainability mediators were introduced, the direct effect became non-significant ($\beta \approx 0.05$, $p = .12$), indicating full mediation. This suggests that digital technologies and supply chain digitalization alone do not guarantee inclusive outcomes unless anchored in sustainability practices. Similar results were observed by Atiase et al. (2022), who found that digitalization efforts without accompanying governance and sustainability structures often fail to generate inclusive benefits. Akosile et al. (2025) likewise stressed that in Nigeria, the realization of digital inclusion depends on the integration of social and economic sustainability practices. Second, the analysis confirmed that DSCM positively influences all three sustainability dimensions, economic ($\beta = 0.44$), social ($\beta = 0.51$), and environmental ($\beta = 0.58$), all $p < .001$. This aligns with Bu and Xie (2024), Gao (2023), and Ozili (2023), who argue that digitalized supply chains enhance resilience, cost efficiency, fairness, and transparency, thereby strengthening sustainability performance. In parallel, Nandi et al. (2021) and Queiroz and Wamba (2019) found that digital technologies such as blockchain, IoT, and AI support social sustainability by promoting ethical sourcing and supplier fairness.

Third, each sustainability dimension significantly predicted digital inclusion, with economic sustainability exerting the strongest effect ($\beta = 0.55$), followed by social ($\beta = 0.24$) and environmental ($\beta = 0.13$). These findings resonate with Fang and Zhang (2021), who showed that digital literacy, fair payment systems, and equitable procurement create opportunities for wider participation in digital ecosystems. Similarly, Dwivedi and Paul (2022) and Ozili (2023) emphasized that financial stability, fair trade, and strong economic practices are necessary foundations for digital or financial inclusion. By contrast, the weaker but significant effect of environmental sustainability differs from evidence in other contexts (Andersson et al., 2022), where regulatory enforcement and mature green finance systems amplify its role. The weaker mediating role of environmental sustainability in this study (indirect effect ≈ 0.08) may thus be context-dependent, reflecting Nigeria's relatively underdeveloped environmental regulation and ESG-linked financing (World Bank, 2022).

Finally, the mediating analysis confirmed that economic (indirect effect ≈ 0.24, CI [0.07, 0.40]), social (0.12, CI [0.05, 0.19]), and environmental (0.08, CI [0.02, 0.14]) sustainability fully explain the DSCM–digital inclusion link. This supports prior research showing that inclusive outcomes depend less on digitalization per se than on the extent to which sustainability dimensions are embedded (Gurzawska, 2020; Dwivedi et al., 2021). While some studies suggest partial mediation, where both direct and indirect paths remain significant (e.g., Gurzawska, 2020), this study found full mediation, underscoring sustainability as a necessary condition for digital inclusion in Nigerian F&B firms. This divergence suggests that contextual differences, in regulatory enforcement, supply chain governance, and resource allocation, shape how sustainability moderates the digital inclusion process (Akosile et al., 2025).

Collectively, these findings demonstrate that DSCM provides the infrastructure and digital backbone, but sustainability practices, especially economic and social, supply the enabling trust, fairness, and legitimacy that translate digital capacity into inclusive outcomes. Environmental sustainability, while significant, remains a weaker pathway in this context, highlighting an area for policy intervention and corporate investment. In sum, the study extends existing scholarship by demonstrating empirically that sustainability is not an optional add-on but

a fundamental pathway through which DSCM fosters digital inclusion in emerging markets such as Nigeria. This study contributes to existing studies by positioning sustainability as the central mechanism connecting DSCM to digital inclusion and by providing empirical insights from an emerging market context where institutional and regulatory conditions differ from advanced economies.

5. Conclusion

This study investigated how DSCM interacts with the three pillars of sustainability, economic, social, and environmental, to shape digital inclusion in Nigeria's food and beverage sector. The results provide compelling evidence that while DSCM enhances sustainability across these dimensions, its influence on digital inclusion is fully realized through the mediating role of sustainability. This finding underscores a crucial insight: digital transformation on its own does not automatically foster inclusion unless it is deliberately anchored in sustainable practices. Of the three pathways, economic sustainability emerged as the most decisive driver, followed by social and environmental sustainability, highlighting the centrality of financial resilience, fair value distribution, and community-oriented practices in advancing inclusion. Theoretically, the study advances scholarship by positioning sustainability as the core mechanism through which digitalization translates into inclusive outcomes. It also adds contextual depth by offering perspectives from an emerging economy where institutional and regulatory conditions present unique challenges and opportunities, often overlooked in studies from advanced economies. Practically, the findings emphasize that the mere adoption of digital tools is insufficient for companies seeking inclusive growth. To achieve meaningful outcomes, F&B firms must align digital innovations with strategies that ensure equitable participation, build capacity, and promote environmental stewardship across all supply chain stakeholders, including employees, suppliers, distributors, and consumers.

Overall, the study concludes that sustainability is fundamental, serving as the essential connection between digital supply chain management and digital inclusion within Nigeria's food and beverage industry. Businesses that incorporate sustainability into their digital transformation plans are better positioned to attain widespread inclusion, enhance their competitiveness, and ensure long-term resilience. Consequently, future prosperity in this industry hinges on the integration of digital innovation with business practices that are sustainable, inclusive, and responsible.

5.1 Practical Implications

The findings of this study carry important implications for managers, policymakers, and development partners. For managers in the food and beverage sector, the results highlight those investments in digital supply chain systems will only achieve their full potential when paired with sustainability-driven strategies. Digital platforms, automation, and data analytics become more impactful when aligned with economic sustainability practices such as fair and timely payments, cost efficiency, and resilient procurement models. Equally, the evidence underscores the role of social sustainability in driving digital inclusion. Firms can foster stronger partnerships and enhance supply chain participation by promoting digital literacy, ensuring fair labor practices, and maintaining transparent communication. These initiatives not only build trust but also equip partners with the capacity to adapt to digital transformation.

Although environmental sustainability showed a relatively weaker effect in this study, it remains a significant factor that managers cannot ignore. Practices such as traceability systems, eco-certifications, and sustainable resource use will likely grow in importance as Nigeria's regulatory frameworks mature and as international buyers increasingly demand environmentally responsible supply chains. Beyond the firm level, the study offers lessons for policymakers and regulators. Policies that incentivize firms to integrate digital supply chain adoption with ESG practices, such as tax reliefs, subsidies, or capacity-building programs, could accelerate digital inclusion across industries. Development partners and international organizations may also play a catalytic role by supporting initiatives that combine digital transformation with inclusive and sustainable outcomes.

5.2 Future research directions

Like all empirical studies, this research is not without its limitations. First, the study employed a cross-sectional design, which restricts the ability to establish causal relationships between digital supply chain management, sustainability dimensions, and digital inclusion. Longitudinal studies could provide deeper insights into how these relationships evolve over time. Second, the focus on the Nigerian food and beverage sector, while offering rich contextual insights, limits the generalizability of the findings to other industries or regions. Comparative studies across different sectors or countries would therefore be valuable in testing the robustness of the proposed framework. The study's methodology incorporated self-reported data from a managerial, officer, and staff cohort. A significant consideration arising from this approach is the potential for response bias, a phenomenon inherent in data collected through self-reporting mechanisms. To address and potentially mitigate this inherent limitation in future research endeavors, it is advisable to integrate objective performance indicators and to diversify data collection strategies by incorporating multi-source data. This augmentation would provide a more robust and triangulated dataset, thereby enhancing the reliability and validity of subsequent findings by offering a counterpoint to potential subjective interpretations or inaccuracies present in self-reported information.

Building on these limitations, future research can extend this work in several directions. Scholars could explore the moderating role of institutional factors, such as regulatory frameworks, market maturity, or technological readiness, on the link between digital supply chains and inclusion. Similarly, qualitative approaches, such as case studies or interviews, could provide richer insights into the mechanisms through which sustainability practices enable digital inclusion. Future research could also investigate additional dimensions of inclusion, such as gender, regional access, or supplier diversity, to uncover how digital supply chains can drive broader social equity. By addressing these areas, future studies can advance both theoretical development and practical understanding of how digitalization and sustainability jointly foster inclusive growth.

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