JURNAL BECOSS
(Business Economic, Communication, and Social Sciences), Vol.7 No.3 September 2025: 271-284 e-ISSN: 2686-2557 DOI: 10.21512/becossjournal.v7i3.14338

Leveraging Emerging Technologies and Sustainability in the Globalization of Lagos State's Supply Chain Policy

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ABSTRACT

The rapid emergence of disruptive technologies in the supply chain has raised significant sustainability concerns. This research aims to evaluate Lagos State's supply chain policies with a focus on the incorporation of emerging technologies and sustainability concerns within the context of globalization. The study applies a qualitative methodology key informant interviews and content analysis to investigate how Lagos can utilize innovations such as IoT, blockchain, and AI to improve supply chain sustainability. The results indicate substantial progress in infrastructure, supported by government investment and modernization initiatives; however, persistent challenges remain, including infrastructure deficits, limited digital access, compliance issues, and difficulties integrating sustainability into policy and practice. The research concludes that harnessing disruptive technologies can help Lagos achieve sustainable economic growth if policies prioritize environmental responsibility and stakeholder collaboration. The novelty of this study lies in its critical assessment of Lagos's dynamic interplay between policy and technology adoption, and sustainability, offering insights and actionable recommendations such as enhanced research investment, continuous policy review, and improved multi-sectoral partnerships to guide future resilient supply chain development.

Keywords: *Emerging Technologies, Globalization, Lagos State Policy, Sustainability Issues, Supply Chain Infrastructure*

INTRODUCTION

Globalization of Supply chain infrastructure globalization is increasingly spreading across the world, offering an opportunity for increased trade, economic development, inter boarder investment and the emergence of metropolitan centers in the global economy. This process has been augmented by the rapid incursion of innovative emerging technologies which offers opportunities to improve efficiency, transparency and resilience within the supply chain networks (Rodchenko., 2023; Zhan & Tan, 2020; Novais et al., 2020; Aamer et al., 2020). However, with these developments, there are still concerns and tensions about the mounting environmental and sustainability challenges which is evident in developing urban region such as Lagos State Nigeria. Lagos State has taken significant steps in policies to modernize and globalize its supply chain infrastructure by leverage emerging technologies such as IoT, blockchain, and artificial intelligence so as to strengthen its competitiveness, attract foreign investors and support export driven industries. Adewole (2019), for example, noted that the Lagos State government has implemented several policy initiatives to improve logistics infrastructure, draw in investment, and support export-oriented industries by creating an efficient and modern supply chain infrastructure, which includes investments in transportation, logistics, and technology. These initiatives focus on creating a resilient and internationally competitive economy.

While the commitment to economic growth and technological adoption is laudable, the effective adoption of these new technologies has been impeded by infrastructure deficits, low digital literacy, and a lack of local technical expertise, especially within the informal sector which is largely excluded from formal supply chain improvements. Furthermore, socioeconomic disparities and the digital divide restrict inclusive participation and equitable benefits among different groups in Lagos. There is also a noticeable gap between policy formulation and practical implementation, particularly in enforcing environmental consideration, sustainability regulations and realizing technology-driven efficiencies. Meagher (2011) pointed out that the size of the state's informal sector makes it difficult to execute and monitor policies effectively. Furthermore, the present rules do not completely address ways to reduce the environmental effect of trade operations, such encouraging eco-friendly transportation and integrating renewable energy sources.

Against this backdrop, there is need for more focused research on sustainable supply chain practices, strategies to bridge the digital divide, stronger integration of informal sectors, and empirical evaluation of policy effectiveness to ensure that globalization, technological advancements, and sustainability progress together in Lagos State's supply chain ecosystem. The study seeks to assess Lagos State's supply chain infrastructure policy framework critically from the perspective of emerging technologies and sustainability. A look into how emerging technologies are being leveraged within Lagos's global supply chain framework, while also analyzing how sustainability objectives are being integrated or neglected within policy and practice. Overall, the study will evaluate the efficacy of current policies and pinpoint opportunities for enhancement towards the sustainability and inclusiveness of the Lagos state supply chain globalization.

In specific terms, the objectives are to:

1. To assess how much the policies in place in Lagos State now encourage the incorporation of innovative technologies into supply chain infrastructure.
2. To evaluate how the state has incorporated sustainability concerns into its supply chain globalization strategy.
3. To examine how innovative technologies might improve the sustainability of Lagos State's supply chain infrastructure, as well as the potential and problems they provide.
4. To make policy suggestions that, in the context of global supply chains, strike a balance between environmental sustainability, economic growth, and technological advancement.

Globalization and supply chain Infrastructure

The terms Globalization has been subjected to extensive reviews and definitions by different authors. Scholars and practitioners have offered various definitions of globalization, reflecting its multifaceted nature. Makarova et al. (2019) describe globalization as a process of international integration across economic, political, cultural, educational, and social dimensions, while World Bank

(2020) emphasizes its role in creating interconnected networks of sourcing, information, manufacturing, logistics, and distribution that transcend national borders. These definitions highlight the integration of technology, communication, supply chain operations and activities beyond national boundaries, facilitating the global movement of capital, goods, services, and information. The impact of globalization has been seen in the area of economic growth, promotion of inequality and increased industrial activity (World Bank, 2020; Nations, 2015). On the other hand, the physical and technological networks that make it easier for information, products, and services to move from supplier to customer on a worldwide basis are the components of supply chain infrastructure. According to Christopher (2016), these comprise digital platforms such as Enterprise Resource Planning (ERP), Blockchain, IoT, and Artificial Intelligence (AI) tools that enhance real-time monitoring, data sharing, and decision-making, communication networks, warehouse facilities, and transportation networks (roads, ports, and airports). With these components, coordination and management are made possible. In the supply chain context, the term "globalization" refers to the process of supply chain operations and activities, network of sourcing, manufacturing, logistics, and distribution networks that cut across national borders and continents to facilitate the effective international movement of capital, products, services, and information (Adewole, 2019).

Global Trends in Supply Chain Management

Advances in technology, shifting customer preferences, shifting economic conditions, and environmental concerns have all influenced the ongoing evolution of global supply chain management. The complexity of supply chains has increased as a result of organizations operating in a more interconnected global environment, calling for creative management and optimization strategies. The design, implementation, and management of global supply chains by enterprises are undergoing a fundamental transformation due to a number of major trends that have surfaced in recent years (Kumar et al., 2020). These patterns show how the sector has responded to issues such as increased sustainability requirements, geopolitical unpredictability, and market volatility. They also highlight the opportunities that emerging technologies and shifting corporate paradigms have to offer. An understanding of these global trends is crucial for policymakers and business leaders, particularly in rapidly developing urban centers like Lagos State. As Lagos aims to position itself as a key player in the global economy, its approach to supply chain infrastructure must align with and leverage these worldwide developments. An outline of some of the trends that are currently shaping the future of global supply chain management will be considered. These trends not only influence how multinational corporations operate, but also can have significant implications for local economies, infrastructure development, and policy formulation.

Digitalization and Industry 4.0

Supply chain management has changed with the introduction of Industry 4.0 technologies, such as blockchain, Artificial Intelligence (AI), and the Internet of Things (IoT). These technologies improve operational efficiency and decision-making processes by enabling real-time data collecting and analysis. IoT devices, for example, make it easier to trace goods across the supply chain, which improves inventory management and shortens lead times. AI applications in predictive analytics help organizations to forecast demand more accurately, thereby optimizing resource allocation and minimizing waste (Rodchenko, 2023; Novais et al., 2020). Furthermore, blockchain technology enhances transparency and traceability in supply chains, which is crucial for ensuring compliance with sustainability standards (Saberi et al., 2018). Artificial intelligence (AI) and machine learning (ML) optimize logistics, predict demand, and automate tasks, improving efficiency and reducing costs (Zhan & Tan, 2020). This can benefit the state by becoming a regional trade hub, while Internet of Things (IoT) sensors can monitor and optimize energy consumption, track goods in real-time, and improve warehouse management. This aligns with Lagos's vision of fostering a green economy. Also, globalized supply chains contribute to greenhouse gas emissions and pollution, whereas automation and AI may lead to job losses in the logistics sector, requiring the policy to adapt and priorities reskilling and upskilling initiatives (Novais et al., 2020). Unethical labor practices and human rights abuses occur in complex global supply chains, while overdependence on specific trade partners can leave Lagos vulnerable to economic disruptions. Lack of infrastructure, regulatory frameworks, trade disruptions and

geopolitical tensions such as global trade uncertainties, political instability, and climate change can disrupt supply chains hindering the successful implementation of the policy (Kazancoglu et al, 2023).

Sustainability and Supply chain

The growing concern over climate change and environmental degradation has pushed sustainability to the forefront of supply chain management making it more increasingly important. Reducing the environmental impact of supply chains through energy-efficient vehicle use, route to optimization, and carbon emission reduction is now a trend as a growing number of businesses are compelled to integrate environmental, social, and economic considerations into their supply chain strategies, moving toward supply chain models that are zero-waste and carbon neutral (Zhang, 2023). In order to establish closed-loop supply chains that are more sustainable, businesses are looking into ways to reuse and recycle commodities. This entails utilizing waste resources as raw materials and creating goods with recycling in mind. Research indicates that organizations that embrace sustainability not only enhance their brand reputation but also attract a growing segment of eco-conscious consumers (Pagell et al.,2008; Xing 2023). For instance, companies like Apple have implemented robust sustainability initiatives throughout their supply chains, focusing on ethical sourcing and reducing their carbon footprint (Xing, 2023), the DHL's GoGreen program whose aim is to reduce all logistics-related emissions to zero by 2050, shows the industry's long-term commitment to sustainability. Also, as part of its Sustainable Living Plan, Unilever pledges to improve people's quality of life along its value chain and source all agricultural raw materials responsibly. Sustainability in the supply chain does not only entail environmental preservation or sustainability but also the economic sustainably and social sustainability. Economic sustainability ensures supplier chains' long-term financial stability while striking a balance with other sustainability objectives. It entails maximizing resources, cutting expenses by eliminating waste, and boosting productivity. Creating value through innovation, risk management, and the development of robust supply chains that can endure disruptions are further components of economic sustainability. The social sustainability on the other hand ensures fair salaries, safe working conditions, and ethical labor standards throughout the supply chain in order to address the human element in supply chains. It highlights ethical sourcing, especially in areas where labor rights can be jeopardized.

Risk Management and Resilience

Global supply chains are vulnerable, as demonstrated by events like the COVID-19 pandemic. The pandemic exposed vulnerabilities in supply chains worldwide, prompting organizations to reassess their operational frameworks and adopt more flexible and agile approaches to mitigate risks that are associated with future disruptions (Heidary, 2022). Businesses are using measures that prioritize sustainability and lower risk in order to increase resilience. These include using sustainable techniques that lessen sensitivity to resource scarcity or environmental shocks and diversifying suppliers to prevent relying too much on one source. Some businesses have adopted nearshoring – which is putting production closer to end markets. Through that businesses may reduce transportation emissions and the risk of global interruptions like natural catastrophes or geopolitical instability by shortening the distance that goods must travel. A study by Ozdemir et al. (2020), revealed that both initiative-taking and reactive resilience-building activities significantly enhanced supply chain velocity during the pandemic and that organizations that prioritized flexibility were better equipped to adapt to changing market conditions and consumer demands. For example, Toyota's adaptive production system, allowed for quick reconfiguration during the pandemic, demonstrates the importance of built-in flexibility.

Talent Development and skills Transformation

The demand for experts with strong digital abilities is rising and in trend as supply chains are becoming more technologically advanced and complicated. A workforce capable of managing, analyzing, and interpreting data is needed for the supply chain operations to incorporate Artificial Intelligence (AI), Blockchain, Internet of Things (IoT), and big data analytics (Gawankar et al., 2020). This will help to enhance decision-making and optimize procedures. These days, employers want supply chain specialists to be technically proficient in fields like automation, digital platforms, and data

analytics. The transition to Industry 4.0 technologies has made hiring individuals capable of operating sophisticated digital networks, automating logistical procedures, and collaborating with innovative software systems imperative for businesses. As a result, companies and educational institutions are coordinating their training programs and curriculum with the digital revolution in the supply chain sector to guarantee that the upcoming generation of workers is suitably qualified for these positions.

Lagos State Policy on Globalization and Supply Chain Infrastructure

Lagos state has made significant policies on globalization and supply chain infrastructure which has positioned the state as a leading logistics and trade hub in West Africa through its strategic geographical location and the growing importance of the region in the global economy. Lagos State contribution of **30% of Nigeria's GDP**, making it the largest economy in the country has been attributed to its strategic position in global and regional trade (Ibrahim et al., 2015). Ozigbo (2020) assert *that* the state has experienced significant direct foreign investment, particularly in sectors such as manufacturing, finance, and technology, leading to economic growth and job creation. However, there are concerns about the uneven distribution of the benefits, with some local businesses struggling to compete with multinational corporations and also the informal economy makes it challenging to strike balance between the need for sustainability and involvement in globalized supply chain (Liu et al., 2014; Ozigbo, 2020*)* Globalization has also exposed the state's economy to external shocks and volatility, as seen during the COVID-19 pandemic and the disruptions in global supply chains. Below are some of the key elements of the state's policies towards harnessing globalization:

- **Infrastructure Development:** The Lagos state government has made significant investments in upgrading and expanding its transport network, including the construction of new seaports, airports, and road infrastructure to improve connectivity and facilitate the movement of goods (Olajide & Lawanson, 2022). Improvements to the road network, such as the construction of new highways, rails, and the rehabilitation of existing roads, have been prioritized to increase logistics and supply chain operations. For instance, ongoing project like the Lagos-Badagry express way, Ojo dualization, Lekki-Epe expressway rehabilitation projects, the development of the Lekki Deep Sea Port, the ongoing expansion of the Apapa and Tin Can Island Ports, the 68km Green Line rail (Marina to Lekki Free Trade Zone), Blue Line extension (Mile 2 to Okokomaiko), the Construction of 13 new jetties and upgrades to existing ones, highlight efforts to leverage waterways for cargo movement, even though implementation delays persist. These infrastructures have been put in place to decongest roads and integrate multimodal logistics. This significant progress has projected the state to become a key gateway for international trade and a hub for West Africa.
- **Socioeconomic Development:** Lagos State's supply chain infrastructure has seen significant investment and development in recent years, notably in the areas of transportation and logistics. Salisu et al. (2022) assert that the growing integration with the global economy has resulted in cultural exchanges as well as exposure to other diverse lifestyles. This has helped Lagos' urban landscape to become more multicultural and livelier, attracting talent and promoting innovation. However, there are also concerns about the influence of globalization on traditional social structures as well as the potential for widening income inequality as the benefits of globalization are not evenly distributed (Olajide & Lawanson, 2022). Migration patterns have also been impacted, with an inflow of both skilled and unskilled labor from other regions of Nigeria and overseas, leading to challenges in urban planning and social cohesion.
- **Lagos State Logistics and Transportation Policy:** Traffic jams, bad road conditions, and inadequate port facilities are just a few of the inefficiencies that have historically beset Lagos' logistics and transportation industry. The introduction of Lekki Deep Sea Port, Construction of thirteen new jetties to leverage waterways for cargo movement and other rail infrastructures which is anticipated to revolutionize marine trade in Nigeria. Offering state-of-the-art facilities that can manage larger vessels and expedite cargo processing procedures, the port hopes to relieve some of the logistical bottlenecks. The policy has the main goals of enhancing efficiency through improved planning and coordination among stakeholders and also to increase the operational efficiency of logistics and transportation networks. Also, the policy tends to draw investments that may result in

the expansion of infrastructure and the enhancement of services by fostering an atmosphere that is favorable to private sector involvement. To meet the expanding needs of the logistics industry, the strategy highlights the necessity of building new facilities and renovating existing ones and also tries to simplify regulatory procedures and lower administrative barriers.

- **Lagos State Export Development Policy:** The policy's goal is to increase Lagos State's export volume, which would support the expansion of the country's economy (Dewi, 2014). The focus is to lessen the state's reliance on oil revenue and to foster a more diversified economy by promoting exports. The policy describes a number of incentives, including tax reductions and financial access, to assist regional companies in exporting their goods. The strategy places a strong emphasis on the development of cutting-edge networks for transportation and logistics that can accommodate a rise in export activity. This program revolves around the Lekki Deep Sea Port, which was built to accommodate higher cargo quantities and increase shipping efficiency (Dewi, 2024).
- **Lagos State Free Trade Zone Policy:** In order to foster the growth of free trade zones which are intended to promote global commerce by providing a range of incentives and regulatory benefits, the Lagos State Free Trade Zone Policy was created. The policy aims to attract both local and foreign investors to establish operations within the free trade zones, thereby stimulating economic growth, enhance competitiveness and job creation (Dewi, 2024). The goal of the program is to lower entrance barriers and expedite trade procedures for companies who engage in international commerce by creating free trade zones. The policy highlights the necessity of creating the utilities, transportation, and logistical infrastructure required to support the activities of free trade zones. Also, it aims to facilitate company operations within free trade zones by lowering bureaucratic barriers and streamlining regulatory procedures.
- **Lagos State Investment Promotion Policy:** With the goal of creating an environment that is favorable to luring and keeping investments in Lagos State, Nigeria, the Lagos State Investment Promotion Policy was developed in 2019. The goal of the strategy is to foster an inviting investment environment that would entice domestic and international businesses to locate and grow in Lagos State. While at that, it aims to keep current investors in the state so they may expand their enterprises by making improvements to the business climate and offering incentives. A strong emphasis is placed on the necessity of building and modernizing infrastructure in order to facilitate investment activities, especially in vital industries like transportation and logistics. In order to make commercial operations easier, the policy attempts to streamline bureaucratic obstacles and regulatory requirements.

Emerging Technologies and prospects of Supply Chain in Lagos State, Nigeria

The recurring population growth and rising urbanization in Lagos has placed pressure on the existing supply chain infrastructure, resulting in bottlenecks and delays. Ineffective customs clearance procedures, bureaucratic red tape, and corruption have long hampered the movement of goods. Similarly, a lack of suitable warehouse facilities, cold chain infrastructure, and multimodal integration has hampered the state's capacity to meet the diversified needs of various industries. The need for significant investment in infrastructure maintenance and upgrading has been a persistent challenge. It is critical to note at this point that a globalized supply chain presents exciting opportunities to leverage emerging technologies and improve efficiency. Lagos stands to gain significantly from the convergence of supply chain globalization and the development of logistics management technology. The city is currently leveraging on emerging technologies to create a more sustainable supply chain, contributing to a greener and more prosperous future for the city (Olajide & Lawanson, 2022). The state government's ambitious plans to develop Lagos as a regional logistics hub, which includes the Lekki Free Trade Zone and other special economic zones, look promising for the future. It is interesting to note that startups are developing innovative solutions for waste management and recycling using IoT and AI. The News Agency (2025) noted it that the 2025-2030 Lagos industrial policy agenda has been focusing on creating technology driven economic powerhouses by incentivizing private-sector partnerships in smart logistics, IoT, and AI for supply chain optimization. Logistics companies are now piloting Electric Vehicles (EVs) and route optimization software to reduce emissions. Businesses are partnering with NGOs to promote

sustainable sourcing practices among farmers and suppliers (Olajide & Lawanson, 2022). Meanwhile, these technologies foster innovation and play a crucial role in transforming Lagos' supply chain management towards greater sustainability in Africa. Below are some of the emerging technologies in supporting sustainable supply chain practices in Lagos State.

- **Renewable Energy Integration:** Supply chain companies in Lagos State are increasingly adopting renewable energy solutions, such as solar power, to power their warehouses, distribution centers, and transportation fleets.
- **Electric and Alternative Fuel Vehicles:** There is a growing trend of logistics providers in Lagos State transitioning their vehicle fleets to electric or alternative fuel-powered options, such as EVs, Compressed Natural Gas (CNG), or biofuels. This shift helps reduce emissions, noise pollution, and dependency on fossil fuels, contributing to more environmentally friendly last-mile deliveries and long-haul transportation.
- **Waste Management and Circular Economy:** Supply chain companies in Lagos State are exploring emerging technologies and solutions to better manage waste generated throughout their supply chain operations. This includes the use of biodegradable or recyclable packaging materials in partnership with private firms to promote a more circular economy and implementing waste-to-energy systems and recycling programs. Two hundred and eighty-seven billion two hundred million naira (N287.2 billion) which amount to 8.5% of the 2025 budget that targets waste-to-energy projects, drainage systems, and public green spaces to mitigate flooding and pollution (Ajia, 2025).
- **Predictive Maintenance and Asset Optimization:** Leveraging predictive analytics and IoT-enabled monitoring, assists logistics providers in Lagos State to anticipate maintenance needs, optimize asset utilization, and extend the lifespan of their equipment and vehicles. Predictive analytics for route optimization and demand forecasting could minimize fuel consumption. This helps reduce waste, minimize downtime, and improve the overall efficiency and sustainability of their supply chain operations. (Trans Info, 2024).
- **Logistic Pooling:** Emerging innovation such as combining multiple businesses shipments or transportation needs to reduce costs and environmental impact. This collaborative idea and shared logistics models in Lagos State has given rooms for coordination and optimization of the use of transportation resources, warehousing facilities, and delivery networks. This collaborative approach helps reduce empty miles, optimize truck utilization, and foster a more sustainable supply chain ecosystem.
- **Traceability and Transparency:** Blockchain, IoT, and other emerging technologies are enhancing traceability and transparency within Lagos State's supply chains, allowing for better monitoring of sustainability metrics such as carbon emissions, water usage, and waste generation. This increased visibility helps supply chain companies make more informed decisions, set targeted sustainability goals, and communicate their environmental performance to stakeholders.

Global Value Chain Theory

The Global value chain (GVC) Governance theory is a vast and evolving theory that explores the mechanisms and dynamics of power, coordination, and decision-making within complex, interconnected production networks. The theory delves into the complex web of relationships and mechanisms that govern how activities are coordinated within global production networks. It explores the "who, how, and why" behind the decisions made in these chains, which stretch across borders and involve multiple actors (Yiu, 2022). These chains encompass the interconnected stages of production and distribution, spreading across different geographical locations. The relationship between GVC governance theory and supply chain logistics infrastructure is complex and multifaceted. On the one hand, the type of governance mechanism used in a GVC can influence the demand for certain types of supply chain logistics infrastructure. For instance, if a GVC relies heavily on just-in-time production, then it will need a well-developed transportation infrastructure to ensure that goods can be delivered quickly and efficiently. On the other hand, supply chain logistics infrastructure can have a significant impact on GVC governance (Börlin, 2022). For example, if the transportation infrastructure is poor, it can make it difficult for firms to coordinate as well as establish close relationships with suppliers, which

can make it more difficult to meet deadlines. This can lead to inefficiencies and higher costs (Sohal & Agrahari, 2018). Conversely, a well-developed supply chain logistics infrastructure can facilitate cooperation as well as coordination and make it easier for firms to govern their GVCs effectively. In conclusion, GVC governance theory and supply chain logistics infrastructure are two important factors that affect the efficiency and effectiveness of global value chains. By understanding the relationship between these two factors, supply chain firms can make better decisions about how to govern their GVCs and how to invest in supply chain logistics infrastructure.

Just Transition Theory

In the discourse surrounding climate change and sustainable development, the idea of a just transition is becoming increasingly important. It highlights the need for equitable solutions that consider the social, economic, and environmental impacts of moving toward a low-carbon economy. As emphasized by the just transition theory, it emphasizes the need to consider the concerns of fossil fuel producers while promoting a green recovery path that is sustainable and equitable (Dewi, 2024). This theory includes social, political, and economic justifications for a wide range of justice concepts. This also asserts that in order to effectively formulate policy, it is imperative to comprehend the trade-offs between quick low-carbon transitions and social fairness (Osho, 2024). The Just Transition idea may be used in the Lagos State Policy on Globalization of Supply Chain Infrastructure to make sure that the infrastructure is developed in a way that supports social justice, economic growth, and environmental sustainability. The Lagos State Government is able to guarantee that the rights and interests of laborers, communities, and vulnerable groups are safeguarded during the construction of supply chain infrastructure. This may be accomplished via offering workers training and skill-development opportunities and making sure that communities are engaged and included in the construction and implementation of supply chain infrastructure. Additionally, by encouraging sustainable practices like the usage of renewable energy and reducing the consequences of climate change, the Lagos State Government may lessen the environmental impact of supply chain infrastructure development. This may be done by investing in the study and development of new sustainable technology as well as by putting laws and regulations in place that promote the adoption of sustainable practices. By including stakeholders in the design and execution of supply chain infrastructure development, such as laborers, communities, and civil society groups, the Lagos State Government can guarantee participatory government.

METHODS

The study examines emerging technologies and sustainability issues, specifically referencing Lagos State policy on the globalization of supply chain infrastructure. The study employs a qualitative exploratory research approach, using key informant interviews and document analysis to examine emerging technologies and sustainability issues in Lagos State's supply chain infrastructure. The research design was chosen to capture rich, in-depth insights from key stakeholders and experts in the field. Qualitative design helps capture in-depth insights and provide a richer source of information (Sætre & Van de Ven, 2021). Twenty-in-depth interviews were conducted with key informants, comprising the following: five government officials from pertinent ministries and agencies; five executives from significant logistics and supply chain companies; five supply chain innovation-focused technology experts; and five sustainability consultants employed by Lagos State. Participants that have specialized knowledge and insights on Lagos State's supply chain policies and infrastructure were chosen through the use of purposive sampling technique. Based on suggestions from the original participants, snowball sampling was used to find more important key informants. Each interview lasted between twenty to twenty-five minutes and was done hybrid based on the participant's preference. Informed consent was obtained from all participants before the interview, while anonymity was maintained throughout the research process. Questions were centered on the infrastructure's existing condition, the efficacy of policies, the adoption of technology, and sustainability issues. Pertinent policy papers such as environmental protection policies and the Lagos Innovation masterplan report on the

supply chain infrastructure of Lagos State from global organizations and the analysis of scholarly research and corporate whitepapers on supply chain developing technologies were considered. The data from interviews are supplemented by document analysis of secondary sources, such as journals, articles, newspapers, and other publications. Every interview was captured on audio and was verbatim transcribed and NVivo software was used for thematic analysis to find reoccurring themes and patterns in the content of documents and interview transcript. The strategy of constant comparison was utilized to enhance and authenticate the themes that surfaced from various data sources. The validity of the instruments was determined by triangulating and contrasting interview data with conclusions from document analysis. To guarantee the openness and reproducibility of the study procedure, an audit trail was kept.

RESULT AND DISCUSSION

According to the body of existing literature, this section presents the study's results and analyzes them in light of the objectives of the study, and the larger body of work on supply chain infrastructure sustainability and new technologies. The findings are derived from the document analysis of pertinent policy papers, reports, and academic publications as well as the theme analysis of twenty key informant interviews participant broken down in the (Table 1) below.

Table 1. Participant in Studies

Participant Group	Number of Participants	Description
Government Officials	5	Officials from pertinent ministries and agencies involved in supply chain policy and regulation.
Logistics and Supply Chain Executives	5	Senior executives from major logistics and supply chain companies operating in Lagos State.
Technology Experts	5	Professionals with expertise in technology-driven innovations.
Sustainability/ Environmental Consultants	5	Consultants engaged by Lagos State on environmental protection and sustainable infrastructure practices.
Total	**20**	

NVIVO Word Frequency Output

A simple NVivo query of the word frequency (minimum length = 5, top 15 words) is highlighted below (Table 2), considering the key recurring terms across interviews and documents:

Table 2. NVivo-generated word cloud of recurrent concepts

Word	Count	Weighted %
Congestion	42	4.5%
Policy	38	4.1%
Technology	35	3.9%
Infrastructure	33	3.6%
Sustainability	30	3.2%
Implementation	29	3.1%
Energy	27	2.9%
Adoption	25	2.7%
Emissions	22	2.4%
Logistics	21	2.3%

The word frequency analysis shows what most recurrent terms are used by interview participants. The top concepts included “congestion” (42 references), “policy” (38), “technology” (35), “infrastructure” (33), and “sustainability” (30). Other significant terms such as “implementation” (29), “energy” (27), “adoption” (25), “emissions” (22), and “logistics” (21) also appeared prominently. This indicates that respondents consistently highlighted the structural, technological, and sustainability challenges facing Lagos State’s supply chain policy.

Thematic Cluster of Results

The four main categories that emerged from the NVivo thematic clustering of policy papers and interview transcripts shown below (Table 3) capture the important aspects of Lagos State's supply chain globalization. The recurring themes in participant narratives produced four thematic clusters: (i) State of Lagos Supply chain; (ii) Policies and technology adoption; (iii) sustainability strategies; and (iv) Technology benefit and challenges. These clusters were obtained by applying cluster analysis, thematic coding, and word frequency searches to the interview transcripts.

Table 3. Thematic Cluster of Results (Weak and strong Representation)

Theme	Strong representation	Weak Representation	(Strength of Representation)
State of Lagos Supply Chain Infrastructure	Port congestion, inadequate road networks, poor warehousing, weak intermodal links, unreliable power supply	Some respondents noted recent road expansions (e.g., Lagos-Badagry Expressway) and ongoing port reforms as signs of improvement.	**14/20**
Policies and Technology Adoption	Lagos Innovation Masterplan, tax incentives, partnerships with tech hubs, policy–practice gap, lack of training	A few respondents highlighted pilot programs (e.g., Lagos Innovation Masterplan) as positive steps, though still small-scale.	**11/20**
Sustainability Strategy	Emission standards, green logistics, renewable energy targets, waste management, circular economy	Some respondents recognized stricter emission standards by LASEPA as progress, even if compliance is difficult.	**10/20**
Technological Benefits and Challenges	Renewable energy integration, IoT in inventory, blockchain traceability, AI/ML optimization, drones for last-mile delivery	Concerns that costs are prohibitive and technology is “not yet realistic” for smaller firms were mentioned by a few.	**15/20**

Theme 1: State of Lagos Supply Chain Infrastructure

This theme was strongly represented by 14 of the 20 interviewees, making it one of the most dominant concerns. Respondents frequently noted that existing facilities were inadequate to meet Lagos State’s growing trade and logistics demands. As a port official noted: “*Our ports are overwhelmed. Apapa and Tin Can Island ports operate well beyond capacity, leading to severe congestion*." Similarly, the observation by a supply chain consultant who noted that “***intermodal connections of the warehouse are insufficient and often lack modern amenities like temperature control."*** reflects a broader issue in many developing regions, where poor integration between transport modes hinders supply chain fluidity. Another significant observation made was on the transportation infrastructure, a minority (6 interviewees) highlighted incremental improvements, especially the Lagos–Badagry Expressway expansion and emerging port reforms. This suggest that the state is not static; rather, piecemeal progress is being made but they appear insufficient. As Participant B noted that “*road networks are improving but still inadequate*”. The Lagos-Badagry Expressway expansion has helped, but we need more arterial roads." Another significant challenge identified was the unreliable power supply, which affects the entire supply chain. These findings corroborates Kuteyi & Winkler (2022) and Rodrigue (2020), who emphasized that inadequate infrastructure is a major bottleneck for supply chain efficiency in Sub-Saharan Africa, leading to increased costs and delays.

Theme 2: Policy and Technology Adoption

Responses clustered around government efforts to stimulate technology adoption, with 11 participants strongly noting policy gaps. Three Technology experts univocally stated that "*policies exist on paper, but there's a gap in translating them to actual tech adoption*." Similarly, a sustainability consultants highlighted that "training programs for emerging tech skills are insufficient to meet industry demands." Although minority voices suggest that foundations are being laid in the area of the Lagos Innovation Masterplan and tax incentives. This divergence highlights that respondents acknowledge policy direction but remain skeptical of its practical impact as its implementation lags due to bureaucratic inefficiencies. This finding is consistent with the findings of Rodrigue (2022), who noted that bureaucratic inefficiencies and resource limitations cause policy implementation gaps, which are a prevalent problem in emerging economies.

Theme 3: Sustainability Considerations

This cluster was evenly emphasized by the participants. All the environmental consultants. noted Sustainability and mentioned recent enforcement of emissions standards by the Lagos State Environmental Protection Agency which has been effective. On the other hand, 5 others noted visible in policy documents which indicted that sustainability is not totally absent from the Lagos state supply chain agenda. On the contrary, the other (10) participant sustainability is often perceived as secondary to economic priorities. They noted "Sustainability is often treated as an afterthought rather than a core strategy in globalization efforts." Also, another noted that "***even though there are laws like tougher emissions regulations and green logistics programs, there is a dearth of enforcement and real-world assistance"***. Three of the consultants categorically recognized progress in emissions regulations but stressed that "compliance is challenging for many companies." These observations align with Hansen & Wethal (2014), who argue a lack of political will and inadequate enforcement mechanisms as problems with sustainability programs in developing nations.

Theme 4: Technological Benefits and Challenges

This cluster shows the possible advantages and difficulties of new technologies for enhancing sustainability and supply chain. This theme expressed both optimism about emerging technologies and concerns regarding feasibility. Fifteen participants engaged strongly with this cluster, underlining the relevance of digital tools for Lagos State's supply chain modernization. As a logistics executive suggested, "*IoT and blockchain could revolutionize our inventory management and reduce waste, but initial investment costs are expensive for many companies*."
On the other hand, concerns over implementation issues were expressed by the respondents, along with excitement about the possibilities of new technology. A logistic and supply chain specialist emphasized the potential of blockchain for traceability, though they cautioned that "*there's a lack of technical expertise locally*." These minority voices remind us that while optimism exists, barriers to adoption are steep and unevenly distributed. This Align with the thought of Mironko & Sagan. (2024) who posited that lack of technical know-how pose a disadvantage to the successful implementation of innovative technologies and that successful technology adoption requires not only policy frameworks but also investments in human capital and public-private partnerships. The Findings revealed that the government could achieve progressive strides by harnessing the potential of emerging technologies and prioritizing sustainability with the rapid emergence of new technologies.

Policy Recommendations

These policy proposals are based on the major findings of the interview responses as they aim to address the opportunities and difficulties found in the supply chain infrastructure of Lagos State. *The* study recommends investment in infrastructural development and expansion strategy for the state's ports, which are key gateways for international trade and vital components of the global supply chain. This will improve port efficiency, capacity, connectivity and reduce congestion, to hinterland markets. The government should enact policies that create an enabling environment for industrial growth, focusing on attracting foreign direct investment and promoting export-oriented industries. For example, Lagos

State should go along with Singapore Economic Development Board (EDB)'s policies and Vietnam's Special Economic Exports Zones (SEZs) by giving companies access to top-notch infrastructure, streamlined customs processes, and tax advantages. The state can establish itself as a competitive participant in the global supply chain and promote sustained industrial growth by taking inspiration from these effective models through creating new free trade zones with simplified rules, providing tax breaks to companies that focus on exports, and making investments in vital infrastructure like roads, ports, and internet access.

Furthermore, the government should prioritize the integration of emerging technologies such as IoT, blockchain and AI into the supply chain operations. This can be achieved by providing tax incentives and subsidies for companies investing in these technologies which is similar to the Singapore's approach to fostering tech adoption in logistics. In addition, there should be a campaign to educate businesses about existing tax incentives for technology adoption in supply chains, embracing public-private partnerships (PPP) to develop supply chain-specific solutions, like IoT-enabled inventory management systems and blockchain for traceability. Also, massive funding through investment in research and development of emerging technologies to support sustainable supply chain management should be encouraged. In the view of sustainability, enforcement of environmental regulations of emissions standards and waste management policies *thr*ough stricter monitoring and penalties for non-compliance should be adopted. Provision of incentives for companies to adopt incentives practices, such as using electric vehicles and optimizing routes to reduce emissions would also be a welcome development. A review and policy update of the policy framework should be done continually as technology also advances to address sustainability challenges.

CONCLUSION

Lagos State's current policy landscape shows a clear strategic intent to incorporate innovative technologies into the supply chain infrastructure, with initiatives such as the Lagos Innovation Masterplan and targeted tax incentives demonstrating policy support for technology adoption. However, the actual implementation remains limited due to challenges like insufficient digital infrastructure, a lack of technical expertise, and the slow pace of policy enactment and awareness campaigns among industry stakeholders. In terms of sustainability, although several policy documents acknowledge the importance of environmental protection and promote concepts like green logistics and stricter emissions standards, practical support and enforcement mechanisms are frequently inadequate, leading to sustainability being treated more as an afterthought than an integral strategy. The potential for emerging technologies- including IoT, blockchain, and AI to enhance the sustainability of Lagos State's supply chain operations is significant; these could foster improved traceability, efficiency, and reductions in emissions and waste. Nonetheless, barriers such as high investment costs, fragmented regulatory frameworks, and limited local technical capacity hamper full realization of these benefits. To move forward, policy recommendations should focus on bridging the gap between policy formulation and implementation by increasing funding for technological infrastructure, developing robust training programs, incentivizing public-private partnerships, and updating regulations to strongly enforce sustainability standards. Striking this balance will enable Lagos State's supply chain ecosystem to achieve long-term global competitiveness through both economic growth and environmental responsibility.

Based on the findings, several key research recommendations can support the sustainable evolution of Lagos State's supply chain infrastructure. First, future research should examine strategies for translating existing policies on technological innovation into more effective and widespread implementation this includes evaluating digital infrastructure investment, targeted industry training, and the effectiveness of tax incentives in stimulating technology adoption. Second, it is recommended to investigate practical mechanisms for deeper integration of sustainability within policies and daily supply chain operations, focusing on case studies of circular economy practices, emissions reduction, and renewable energy deployment in logistics. Third, further research is needed to identify best practices for bridging the digital divide and integrating the informal sector into formal, technology-enabled, and

sustainable value chains, thus ensuring inclusivity and equitable growth. Fourth, researchers should explore models of public-private and multistakeholder partnerships specific to African urban contexts, which can advance innovation, sustainability, and regulatory compliance at scale. Continuous monitoring and policy adaptation studies are also necessary to guide ongoing review and refinement of supply chain strategies, balancing environmental, technological, and economic priorities for resilient and globally competitive outcomes in Lagos State.

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