World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(REVIEW ARTICLE)

A FRAMEWORK OF TECHNOLOGICAL INNOVATION AND SUPPLY CHAIN EFFICIENCY IN THE NIGERIAN BREWERY INDUSTRY: A LITERATURE REVIEW FOR SOUTH-EAST NIGERIA

Stanley Chinedu Okwuonu [1], Emmanuel Chijioke Nwadike [2,*] and Joachim Chinonyerem Osuagwu [2]

[1] Department of Procurement Management, Centre of Excellence in Sustainable Procurement, Environmental and Social Standards (CE-sPESS), Federal University of Technology Owerrri, Nigeria
[2] Federal University of Technology Owerri, Nigeria.
* Corresponding Author: chijioke.nwadike@futo.edu.ng

ORCID Details
Emmanuel Chijioke Nwadike: https://orcid.org/0000-0001-5177-0230
Joachim Chinonyerem Osuagwu: https://orcid.org/0000-0001-8750-3564

World Journal of Advanced Research and Reviews, 2026, 32(02), 415–420

Publication history: Received on 20 September 2026; revised on 02 November 2026; accepted on 04 November 2026

Article DOI: https://doi.org/10.30574/wjarr.2026.32.2.2786

Copyright © 2026 Author(s) retain the copyright of this article. This article is published under the terms of the Creative Commons Attribution License 4.0

ABSTRACT

The competitiveness of breweries is central to supply chain efficiency, this is an indication on the technological innovation that improves it in the Nigerian nation and this is spread across single – firm studies on general manufacturing surveys and international reviews. This article reviewed works from 2020 to 2024 on supply chain efficiency, technological innovations and digitalization with prominence on food, beverage and the Nigerian brewery location. It was evident that international breweries links industry 4.0 technologies example is the blockchain, Internet of things and data analytics, this is traceable, visible and strong supply chain performance, but the improvement depends on the precarious factors and can nose dive where systems are incompatible or the conditions are ambiguous. The Nigerian evidence is inadequate, often single-firms, and in some cases appears to depend on overlapping samples. It points to positive links between technology, supply chain practices and performance, alongside low uptake of high-end digital technologies. Drawing on these strands, the paper proposes an integrative framework in which technological innovation improves supply chain efficiency through enabling mechanisms, with outcomes moderated by contextual conditions in South-East Nigeria, and sets out four propositions for future testing.

Keywords: Technological innovation; Supply chain efficiency; Brewery industry; Industry 4.0; blockchain; South-East Nigeria, conceptual framework.

1 INTRODUCTION

Technological innovation has become a growing important factor of competitiveness in present day manufacturing and supply-chain management. The swift development of digital technologies has transformed how firms get materials, coordinate suppliers, manage production, regulate inventories, distribute finished merchandises and respond to customer demand. In particular, the advent of Industry 4.0 has announced a broad range of technologies, these

technologies include the following artificial intelligence (AI), Internet of Things (IoT), big-data analytics (BDA), blockchain, cloud computing, robotics, automation, simulation and cyber-physical systems into industrial and supply-chain processes, Ugwu & Balogun 2024.

Technological innovation is widely proposed as a route to more efficient supply chains. International reviews report that Industry 4.0 technologies influence supply chain performance in many ways, while stressing that benefits depend on critical success factors (Rad et al., 2022).

A review of 68 papers similarly concluded that Industry 4.0 technologies shape supply chain

Performance in several ways and recommended a holistic, integrated approach to adoption (El Jaouhari et al., 2023). Data analytics and end-to-end digitalization of processes have been identified as important drivers of performance gains, although adoption can still fail where market conditions are difficult, internal systems are incompatible, or complexity and uncertainty are high (Birkel, 2021).

Supply chain efficiency means the various methods firms / companies manages the movement of materials resources, information, products, and money from their suppliers to consumers while minimizing cost, waste, time, and errors, Santoso et al., 2022).

Supply chain management is the centralized administration of the flow of goods and services to and from an organization, it includes all the methods tangled in converting raw materials and components into finished products. Supply chain management components can reduce costs and convey products to the customers faster and more efficiently. The five most vital phases of supply chain management are planning, sourcing, production, distribution, and returns. A supply chain manager is commissioned with monitoring and cost reduction to avoid supply chain shortages, Fernando et al (2024).

Brewing depends on tightly coordinated supply chains. Grains, malt, packaging materials, water and energy must arrive reliably, and perishable finished products must reach distributors without delay. In Nigeria, this coordination is complicated by unreliable power, high logistics costs and import dependence for some inputs Ugwu & Balogun 2024.The South-East is a long-standing brewing region, and breweries there, including the plant at Ama, Enugu, are important to both firm competitiveness and regional economic activity.

The research work portrayed that Nigerian brewery is growing but fragmented, Studies addressed that block chain and materials management at a single brewery, Chukwu et al, 2024. Agu 2024 opined that supply chain practices and production cost, Also Nwatu 2021 and Adeyinka 2023 confirmed that digital transformation is required across manufacturing firms in the South East of the nation.

There is no study reviewed in the work that merges this evidence into a framework in breweries in the South-East of Nigeria. This study reviewed some significant literature and recommends this framework.

The study is guided by the following research questions;

- **RQ1:** What are the technological innovations that have been examined in food, beverage and brewery supply chains?
- **RQ2:** To what extent are they linked to supply chain efficiency?
- **RQ3**: In what ways are the contextual conditions in Nigeria likely to shape the link?

1.1 Problem statement

In spite of a strong international case for technology-supported supply chains, Nigerian breweries is in dearth of a consolidated evidence vile on how innovation explains into supply chain efficiency. Three problems are pointed out in this work.

First, it is evidenced that single firms are often limited and fragmented, The Nigeria breweries at Ama, Enugu observed a positive association between profitability and technological applications, but researchers acknowledge that a firms plan cannot be universal to the broader brewery sub sector in South East Nigeria, (Chukwu et al., 2024).

Secondly it is well known that there is no specific context framework, globally reviews offer Industry 4.0 framework, Rad et al., 2022 and El Jaouhari et al 2023, it is noted that their works was not built around the Nigerian nation such as energy cost, deficits in infrastructure and irregular digital capabilities. The studies in our Nation proves that the application of digital technology remains skewed near low end -devices, with high end technologies are still sporadic.

Thirdly it was discovered that adoption carries application risk, better performance is not guaranteed on technology, unsuitability, difficulty and uncertainty may cause failure (Birkel, 2021). Kumar et al., 2020 opined that block-chain presented as a solution faces technical challenges. It was addressed that managers of breweries and their policymakers in the South East region lack created guidance on which technology work, over what mechanisms, and what are the conditions.

2 CONCEPTUAL BACKGROUND

2.1 Technological innovation

This study discusses technological innovation as the adoption of new or enhanced technologies and methods that change how products are prepared, tracked and stirred. The industry 4.0 provides the leading vocabulary, with technologies such as IoT, big data analytics, cloud computing, artificial intelligence and blockchain, and Rymarczyk, (2020) opined that discusses both their opportunities and challenges was discussed in his literature. Also Process innovation, for example workflow automation, was treated together with digital technologies since breweries are process industries.

2.2 Supply chain efficiency

Supply chain efficiency is explained as the capacity to distribute products with minimum cost, reliable delivery period, short lead times, high inventory revenue and reduced waste. Research domiciled in Nigeria reveals that operationalized production cost leads to high productivity (Agu 2024; and Nwatu 2021.) Also Adeyinka 2023 stated that firm's efficiency is measured through data envelopment analysis

3 REVIEW OF LITERATURE

3.1 Industry 4.0 and supply chain performance: International evidence

There is a substantial review level evidence on industry 4.0. In a systematic review of 221 papers ranging from 11 core technologies, published between 2005 to 2001 with synthesized benefits with challenges and serious achievements for each technology and called for extra work on technological interactions and on under-utilized technology (Rad et al., 2022).Secondly a review of 68 papers surveyed how Industry 4.0 technologies touch net-zero supply chain performance and projected a conceptual framework for strategic acceptance (El Jaouhari et al., 2023). A third synthesis found that data analytics and seamless data flows, enabled by end-to-end digitalization, are important performance drivers, and that most organizations experience improvements after adoption but not all (Birkel, 2021). With the consideration of this reviews, it was suggested that a steady pattern, technology matters through intermediate tools like data flow and visibility and market circumstances. Based on this logic a framework was developed.

3.2 Blockchain, IoT and traceability in food and beverage supply chains

The breweries handle food-grade products, the food supply chain literature is directly relevant. A review of blockchain-based frameworks analyzed 54 food traceability and supply chain frameworks and concluded that blockchain plays an important role in improving traceability and supply chain operations (Ellahi et al., 2023). Within those frameworks, IoT was combined with blockchain in 37 cases, RFID in 26, and cloud computing and QR codes in 23 each, whereas artificial intelligence (13) and big data analytics (12) were used far less (Ellahi et al., 2023). The same review noted limitations, including scalability, energy consumption and storage requirements.

Two points matter for the Nigerian brewery case. First, most evidence concerns traceability and information integrity, which are plausible enabling mechanisms for efficiency but are not efficiency outcomes in themselves. Secondly, evidence from developing contexts is thin. One exception is a blockchain-based approach to traceability and management of a food value chain in Nigeria, which combined blockchain with technologies such as RFID, GPS and NFC (Akazue et al., 2023).

3.3 Supply chain practices and performance

In Nigerian manufacturing sector studies generally report positive links between supply chain practices and performance. A survey of quoted manufacturing organizations found positive and statistically significant relationships between procurement outsourcing, information flow management and order process management and firm performance (Samuel & Gabriel, 2022). Work on ICT adoption and supply chain integration in Nigeria developed a conceptual model in which integration mediates the effect of intra- and inter-organizational ICT on supply chain performance (Mohammed, 2024). The mediation idea is consistent with the international view that technology works through intermediate capabilities.

Digital skills and capability among the South East Nigerian breweries is irregular, Studies shows that the Nigerian manufacturing companies use data envelopment analysis and Tobit regression observed that the acceptance of digital technology was focused in low end devices whereas the high end technologies required for digital transformation were still scarce and this calls for training and manpower development to build digital capacity Adeyinka, 2023). The results succeeds an optimistic hope about technology, since productivity effects rely on technologies being deployed intensely enough to change procedures.

3.4 Evidence from Nigerian breweries and South-East Nigeria

It is well known that there is minor literature on brewery, The Nigerian breweries at Ama in Enugu applied technology in materials management was positively correlated with profitability, Also block chain was related to sustainable supply chain management, Chukwu et al, 2024 the authors findings from one firm cannot be used to generalize with other firms. Agu, 2024 and Nwatu, 2021 stated that studies in brewing plants in South East Nigeria reports that constant improvement affects product quality and supply chain practices relate strongly to cost of production.

3.5 Contextual conditions in Nigeria

The operation environment in Nigeria is moderate and the benefits of technology is not well utilized, unstable electricity supply, high dependent on generating plants for power which increase the cost of production, poor road network, insecurity and poor road network for delivery of finished products, port logistics increase cost and time of moving goods Ugwu & Balogun 2024, technical skills are repeatedly acknowledged as a constraint on digital transformation (Adeyinka, 2023). These situations are likely to affect whether IoT sensors, cloud systems or blockchain platforms can - run reliably in a brewery, and they stimulate treating context as a moderating layer in the framework.

4 SYNTHESIS AND RESEARCH GAPS

Table 1 summarizes the Nigerian studies reviewed, four gaps was identified

First, no study tests technological innovation and supply chain efficiency jointly across several breweries in South East Nigeria. Secondly the mechanisms that link technology to efficiency, such as visibility and automation, are assumed rather than measured. Thirdly, contextual moderators are discussed but rarely modelled and fourth there are signs of overlapping sections and varying performance measures, which limit comparability.

Table 1: Literature reviewed summarized by study setting, focus, and main findings tabulated

Study	Setting	Focus	Main finding
Chukwu et al. (2024)	Nigerian Breweries, Ama, Enugu	Materials management, blockchain, efficiency	Technology positively correlated with profitability; single-firm limitation
Agu (2024)	Brewing plants, South-East	Lean practices, supply chain, JIT	Continuous improvement affects quality; strong supply chain–cost correlation
Nwatu (2021)	Brewing plants, South-East	Supply chain and production cost	Significant relationship (r = .866); sample size matches Agu (2024)
Samuel & Gabriel (2022)	Quoted manufacturers, Nigeria	Procurement, information flow, order processing	Positive, significant link to performance
Adeyinka (2023)	Nigerian manufacturing	Digital technology and firm efficiency	Uptake skewed to low-end technology; high-end uptake low
Mohammed (2024)	Nigerian supply chains	ICT adoption, integration, performance	Conceptual model with integration as mediator
Akazue et al. (2023)	Food value chain, Nigeria	Blockchain traceability	Blockchain-based approach proposed for traceability and management

5 PROPOSED CONCEPTUAL FRAMEWORK ON THE REVIEWED LITERATURE

Figure 1 presents an integrative framework, Technological innovation, comprising digital and information systems, blockchain traceability, IoT and automation, process innovation and data analytics, is estimated to improve supply chain

efficiency through enabling mechanisms like information sharing and visibility, workflow automation, materials management and supplier collaboration.

Efficiency is gained in cost, delivery reliability, inventory turnover, lead time and waste are expected to turn into firm outcomes such as profitability, quality of product, satisfaction of customers and competitive advantage. Contextual conditions in South-East Nigeria moderate these links.

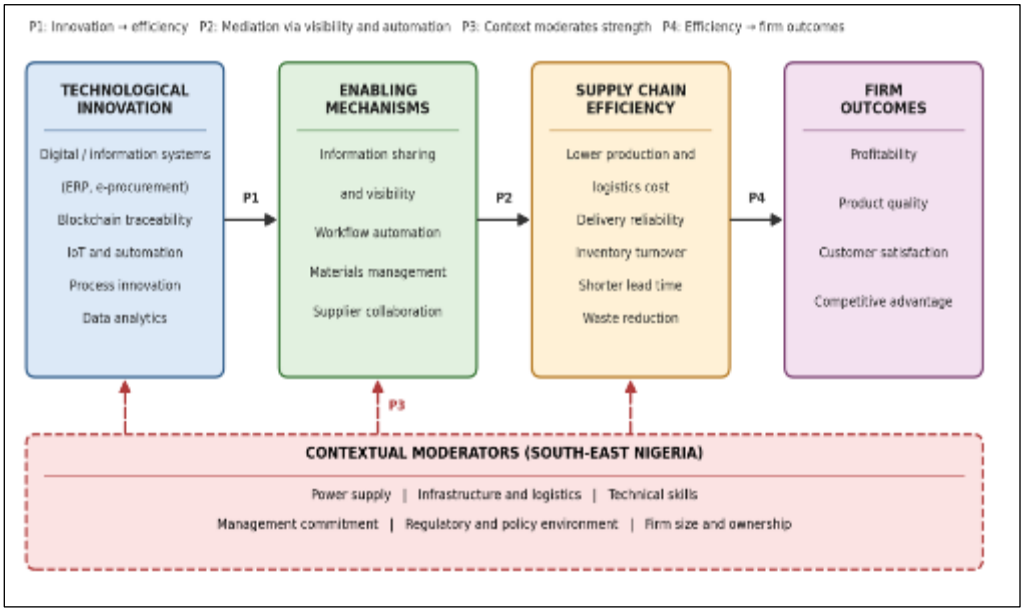


Figure 1: Conceptual Framework of Technological Innovation and Supply Chain Efficiency in the Nigerian Brewery Industry (South-East Nigeria)

Note. Solid arrows show the proposed flow; dashed arrows show contextual moderators. Developed by the authors from the reviewed literature.
Source: Authors computation 2026

Table 2: Propositions derived from the literature

Proposition	Relationship	Grounding in the literature
P1	Technological innovation improves enabling mechanisms (visibility, information sharing, automation)	Data analytics and end to end digitalization drive performance (Birkel, 2021) blockchain and IoT improve traceability (Ellahi et al., 2023).
P2	Enabling mechanisms improve supply chain efficiency	Information flow and order management relate positively to performance (Samuel & Gabriel, 2022); integration mediates ICT effects (Mohammed, 2024).
P3	Contextual factors (power, infrastructure, skills, management commitment, policy, firm size) moderate these links	Benefits depend on critical success factors (Rad et al., 2022); high-end technology uptake and skills are limited in Nigeria (Adeyinka, 2023).
P4	Supply chain efficiency improves firm outcomes	Positive links with profitability and cost outcomes (Agu, 2024; Chukwu et al., 2024; Nwatu, 2021).

6 IMPLICATIONS AND DIRECTIONS FOR FUTURE RESEARCH

It is advised that brewery managers, should review evidence suggesting sequencing investment, also building data flow and visibility with proven tools, then add higher-end technologies such as blockchain traceability or analytics where infrastructure and skills. Policymakers, the repetitive emphasis on skills and irregular digital capability (Adeyinka, 2023; Rad et al., 2022) supports targeted training and infrastructure support.

Researcher's priorities include a multi-brewery studies in South-East Nigeria, the measurement of the mediating mechanisms in the framework, clear modelling of contextual moderators, and transparent recording of data sources so that studies can be treated as independent evidence.

7 CONCLUSION

Sequel to the review, technological innovation can improve supply chain performance, through the enabling mechanism and beneath conditions that vary by context. Evidence from Nigeria is promising yet narrow, focused in single firms and in areas overlapping. This framework suggests links to technological innovations, enabling mechanisms, supply chain efficiency and firm's outcomes, through contextual moderators particular to South – East Nigeria. The four suggestions provide a basis for empirical testing and for more context sensitive technology.

REFERENCES

[1] Adeyinka, F. M. (2023). Digital transformation and firm efficiency in the Nigerian manufacturing sector. Economic Horizons, 25(3).

[2] Agu, O. (2024). Lean management practices and organizational performance: An experience from brewing plants in South East, Nigeria. European Journal of Interdisciplinary Studies, 10. https://doi.org/10.26417/fwnd0167

[3] Akazue, M. I., Yoro, R. E., Malasowe, B. O., Nwankwo, O., & Ojugo, A. A. (2023). Improved services traceability and management of a food value chain using block-chain network: A case of Nigeria. Indonesian Journal of Electrical Engineering and Computer Science, 29, 1623–1633.

[4] Birkel, H. (2021). Operationalizing the value of Industry 4.0 technologies for supply chain performance. Academy of Management Proceedings, 2021(1), Article 15761. https://doi.org/10.5465/AMBPP.2021.15761abstract

[5] Chukwu, U. C., Igwe, N. N., Anichebe, N. A., Alinno, F. C., Oparah, F., & Obodoagu, K. O. (2024). Materials management and adoption of blockchain technology on supply chain efficiency: A study of Nigerian Breweries Ama Enugu Nigeria. RGSA – Revista de Gestão Social e Ambiental, 18(10), 1–20.

[6] El Jaouhari, A., Arif, J., Samadhiya, A., & Kumar, A. (2023). Net zero supply chain performance and Industry 4.0 technologies: Past review and present introspective analysis for future research directions. Heliyon, 9(11), Article e21525, https://doi.org/10.1016/j.heliyon.2023.e21525

[7] Ellahi, R. M., Wood, L. C., & Bekhit, A. E.-D. A. (2023). Blockchain-based frameworks for food traceability: A systematic review. Foods, 12(16), Article 3026. https://doi.org/10.3390/foods12163026

[8] Kumar, A., Liu, R., & Shan, Z. (2020). Is blockchain a silver bullet for supply chain management? Technical challenges and research opportunities. Decision Sciences, 51, 8 37.

[9] Mohammed, A. (2024). The cumulative effects of ICT adoption and integration practices on supply chain performance in Nigeria [Doctoral thesis, University of Central Lancashire]. https://doi.org/10.17030/uclan.thesis.00052509

[10] Nwatu, C. (2021). Supply chain and production cost of brewing plants in South-East, Nigeria. International Journal of Trend in Scientific Research and Development, 5(5). https://www.ijtsrd.com/papers/ijtsrd44965.pdf

[11] Rad, F. F., Oghazi, P., Palmié, M., Chirumalla, K., Pashkevich, N., Patel, P. C., & Sattari, S. (2022). Industry 4.0 and supply chain performance: A systematic literature review of the benefits, challenges, and critical success factors of 11 core technologies. Industrial Marketing Management, 105, 268–293.

[12] Rymarczyk, J. (2020). Technologies, opportunities and challenges of the industrial revolution 4.0: Theoretical considerations. Entrepreneurial Business and Economic Review, 8, 185-198.

[13] Samuel, O. O., & Gabriel, K. T. (2022). Supply chain management and performance: Evidence from manufacturing organizations in Nigeria. Journal of Technology and Operations Management, 17(2), 71–84.

[14] Ugwu, K. E., & Balogun, O. (2024). Navigating supply chain management: Technology adoption in Southeast Nigerian breweries. Journal of Commerce, Management and Tourism Studies, 3(3), 231–243. https://doi.org/10.58881/jcmts.v3i3.231