

Effect of Digital Transformation on Supply Chain Resilience in the Nigerian Manufacturing Sector

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Abstract— Digital transformation technologies offer numerous benefits including improved visibility, agility and risk management but its adoption is often hindered by inadequate infrastructure, skills shortages and organizational resistance. The understanding of the interplay between digital transformation technologies and the supply chain resilience become necessary as a result of balancing environmental, social, and business outcomes which become a fundamental requirement for the supply chain sector. The study sought to; examine the effect of digital transformation technologies on supply chain operations; to assess the relationship between digital transformation technologies and supply chain efficiency; to evaluate the extent to which digital transformation technologies influence supply chain resilience. The study used mixed methods research design. The paper used primary data with 200 questionnaires for respondents from both junior and senior staffs using stratified random sampling techniques. The statistical techniques used for the study were Principal Component Analysis (PCA) for objective one, Pearson Product Moment Correlation (PPMC) for objective two and multiple regression analysis for objective three. The result of the study revealed that the principal component (PC 1) explains the largest portion of the variance, about 46.02%, followed by PC 2, explains an additional 24.88%. Together, these two components account for 70.90% of the variance, meaning that they are captured most of the information from the original data. The remaining components, PC 3 and PC 4, explain much less variance, suggesting that they add less important information. PPMC show that there is a strong positive significant relationship between digital transformation technologies and supply chain efficiency and multiple regression revealed that digital transformation technology has significant effect on supply chain resilience. Based on the result of findings, it was concluded that; Block chain technology, artificial intelligence, internet of thing and big data analytics are the digital transformation technologies that enhance supply chain operation, efficiency, transparency, traceability and resilience. The management of the firms should invest more on research and development on digital transformation as this will go a long way in improving the digital transformation technologies, thereby, enhancing supply chain resilience.

Keywords— Digital transformation, supply chain resilience, efficiency and transparency.

I. INTRODUCTION

Digital transformation (D.T) refers to the comprehensive adoption of digital technologies to fundamentally improve organizational operations and capabilities (Korherr et al., 2022; Ghafoori et al., 2024; Lu, Q. et al., 2024a). It is often defined as “a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” such as big data analytics, cloud platforms, Internet of Things, AI and block chain (Vial, 2021). The increasing complexity and interconnectedness of global supply chains have heightened the risk of disruptions, which can have severe consequences for businesses and economies. In today's era of industrial development and commercial growth, sustainable practices have become indispensable for operative environmental management. The earnestness to address and alleviate negative environmental impacts has never been greater (Ghadge, 2020). Achieving sustainability and effectively balancing environmental, social, and business results has become an ultimate obligation for the supply chain sector. The increasing volume of products being transported through supply chains has significantly intensified the carbon footprint, give away a substantial environmental challenge. To address this, manufacturers are turning to a variety of technologies and strategies to enhance their sustainability efforts (Abanijing, 2025). Key approaches include digital transformation

technologies such as block chain, artificial intelligence and reverse logistics. By integrating these advanced technologies, companies aim to enhance their operational efficiency and reduce their environmental impact.

Despite the growing importance of supply chain resilience, many organizations struggle to effectively leverage digital transformation technologies to mitigate these risks (Ivanov et al., 2021). Digital transformation technologies offer numerous benefits including improved visibility, agility and risk management but its adoption is often hindered by challenges such as inadequate infrastructure, skills shortages and organizational resistance (Belhadi, 2024). The lack of clear understanding on how to effectively utilize digital transformation technologies to enhance supply chain resilience is a significant problem. Many organizations are investing heavily in digital transformation initiatives without fully understanding their impact on supply chain resilience (Wu et al., 2024). This knowledge gap can lead to ineffective implementation, wasted resources, and decreased competitiveness.

Furthermore, the rapidly evolving nature of digital technologies and the increasing complexity of global supply chains create new challenges for organizations seeking to build resilient supply chains (Sengupta et al., 2022). To address these challenges, organizations need to develop a deeper understanding of how digital transformation technologies can be leveraged to enhance supply chain resilience. The study

sought to; examine the effect of digital transformation technologies on supply chain operations; to assess the relationship between digital transformation technologies and supply chain efficiency; to evaluate the extent to which digital transformation technologies influence supply chain resilience.

Conceptual clarification

Digital Transformation

The term "digital transformation" describes how digital technologies are incorporated into every aspect of a company, radically altering how businesses function and provide value to their clients. In order to improve corporate processes, operational efficiency, and innovation, it entails implementing cutting-edge technologies like cloud computing, data analytics, the Internet of Things (IoT), artificial intelligence (AI), automation, and digital platforms. In addition to implementing new technology, digital transformation aims to modify the organization's culture so that it can react more quickly to changes in the market, client needs, and competitive challenges. In the context of businesses, digital transformation often includes the automation of manual processes, digitization of products and services, and leveraging data to drive decision-making. For supply chains, this could involve real-time tracking, predictive analytics, digital twins, and smarter inventory management systems that optimize operations and reduce costs.

Digital transformation refers to the comprehensive adoption of digital technologies to fundamentally improve organizational operations and capabilities (Korherr et al., 2022; Ghafouri et al., 2024; Lu, Q. et al., 2024a). It is often defined as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2021). In a supply chain context, digital transformation entails deploying innovations such as big data analytics, cloud platforms, Internet of Things. Digital technology is essential for improving the efficiency and reliability of the supply chain. Large datasets are analyzed by ML algorithms to find possible hazards and improve inventory control, which lowers operating expenses and raises customer satisfaction. By offering real-time asset and shipment monitoring across the supply chain, IoT expands this capability and improves visibility and responsiveness (Kache & Seuring, 2017). By safely logging transactions and tracking product movements, blockchain technology guarantees data accuracy and transparency, which is crucial for upholding confidence and lowering fraud. Agile decision-making and flexible supply chain tactics are made possible by these digital innovations, which are essential for prospering in the fast-paced, cutthroat business world of today. Businesses can achieve sustainable growth, reduce risks, and streamline operations in the face of changing market condition by integrating these technologies.

Supply Chain Resilience

The ability of a supply chain to foresee, plan for, react to, and recover from disruptive events is known as supply chain resilience. It includes both reactive recovery and adaptation measures as well as proactive risk mitigation strategies (Christopher & Peck, 2004). The impact of interruptions on corporate performance is reduced by resilient supply networks,

which are built to endure shocks and preserve business continuity (Sheffi & Rice Jr, 2005). Flexibility, agility, and redundancy are essential components of resilient supply chains that let businesses swiftly adjust to shifting circumstances and effectively resume regular operations (Ponomarev & Holcomb, 2009). Businesses must comprehend and improve supply chain resilience in order to maintain a competitive edge and guarantee long-term viability in a world that is becoming more unpredictable by the day.

Natural catastrophes, geopolitical conflicts, and pandemics are just a few of the many disruptions that supply chains encounter in today's globalized and linked world, and they can have a big influence on how businesses operate. It is impossible to overestimate the significance of resilience in this context since it helps businesses to endure and bounce back from such disruptions (Tang, 2006). To guarantee continuity and reduce losses during disruptions, modern supply chains need to be resilient and flexible. By enabling businesses to sustain service standards and client happiness in the face of adversity, resilience gives them a competitive edge (Wieland & Wallenburg, 2013). Investing in resilience is essential for maintaining competitive advantage and long-term viability in an uncertain global context as shocks become more frequent and complex.

The ability of supply chains to recover from unanticipated disturbances and preserve operational efficacy is at the heart of the notion of supply chain resilience (Sheffi, 2005; Christopher, 2016). According to Gogli et al. (2023), supply chain resilience is the capacity of a supply chain to foresee, plan for, react to, and recover from interruptions while preserving its core operations. This idea moves the emphasis from just increasing efficiency to enhancing supply chains' flexibility and adaptability. The relationship between SCM and resilience is frequently discussed in scholarly works as a way to strike a balance between the necessity of efficiency and the capacity to withstand unforeseen shocks.

Review of related works and Theory

Digital transformation significantly enhances supply chain transparency and traceability by leveraging technologies such as block chain, internet of things (IoT) and big data analytics. According to He et al (2024) digital transformation improves supply chain transparency by providing real-time data and analytical tools, strengthening monitoring processes and risk management. This is supported by Ning and Yao (2023) who found that digital transformation enhances supply chain capabilities including information exchange, activity integration and responsiveness. Block chain technology in particular provides a secure and immutable record of transactions, enabling transparent tracking of products and reducing counterfeiting (Kamble et al., 2023) IoT enables real time monitoring and tracking of products and improving supply chain visibility and responsiveness (Li et al., 2023) but the application of digital transformation remains within the context of Nigerian manufacturing and service industries.

According to Ning and Yao (2023) digital transformation optimize product development, warehouse management, logistics visibility and quality traceability leading to effective improvements in supply chain network and business processes.

Additionally, digital transformation promotes collaboration among supply chain participants creating synergy and stability throughout the entire supply chain. Therefore, digital transformation significantly improves supply chain operations by leveraging technologies such as AI, internet of Things and block chain (Khan, N. 2023; Ali, A.,2023). but there is paucity of studies in developing economies such as Nigeria on the effect of digital transformation technology on supply chain operations.

Digital transformation in supply chain has received growing attention as a pathway to efficiency, transparency by improving the internal governance and external market competition. According to Fan et al (2024) digital transformation add to supply chain efficiency and transparency by providing real-time data and analytical tool strengthening monitoring processes and risk management. This study highlight that Nigerian manufacturers could benefit from digital transformation technology with guarantees of data accuracy, transparency, efficiency which is crucial for upholding confidence and lowering fraud. Agile decision-making and flexible supply chain tactics are made possible (Abanijigi,2025). However, lack of technical know-how, inadequate infrastructural and epileptics supply of electric hinder the effective implementation of digital transformation technologies in Nigeria. It is evident that companies in some countries like Singapore, china etc. make use of digital transformation technologies (Junbo, 2024, Lianju,2023, Ning, 2023) with no empirical studies in Nigerian context on the relationship between digital transformation technologies and supply chain efficiency.

Ning and Yao (2023) opined that digital transformation plays a crucial role in enhancing supply chain resilience by improving supply chain visibility, transparency and agility. According to stroumpoulis et al (2024). Digital transformation enables companies to respond quickly to changing market conditions and disruptions improving supply chain resilience. For instance, a study on the impact of digital transformation on supply chain found that it improves supply adaptability and responsiveness (Ivanov et al, 2021). In the qualitative investigation of Gupta and Sharma (2020) examined how digital technology may be used to reduce supply chain risks in the food processing sector. Annosi, et al (2021) worked on digitalization within food supply chains to prevent food waste. However, there is limited to the level of awareness of the impact of supply chain resilience (Wu et al.,2024). This knowledge gap leads to ineffective implementation, wasted resources, and decreased competitiveness. Therefore, there is need to evaluate the extent to which digital transformation technologies influence supply chain resilience

Resource-Based View (RBV)

The theory was originated by Werner felt (1984) and further developed by Barney (1991), the RBV emphasizes the role of firm-specific resources and capabilities in achieving competitive advantage. In the context of digital transformation and supply chain resilience, the RBV suggests that organizations can leverage digital technologies as strategic resources to enhance their resilience capabilities. The integration of IoT sensors, Block chain and AI algorithms can enable real-time data capture and analysis, providing

organizations with valuable insights for improving responsiveness and risk mitigation in their supply chains (Srinivasan et al., 2022).

Conceptual framework

The framework treats supply chain resilience as the dependent variable which was measured by digital transformation technologies as independent variable proxies by Block chain technology, Artificial Intelligence, Internet of things and Big Data Analytics.

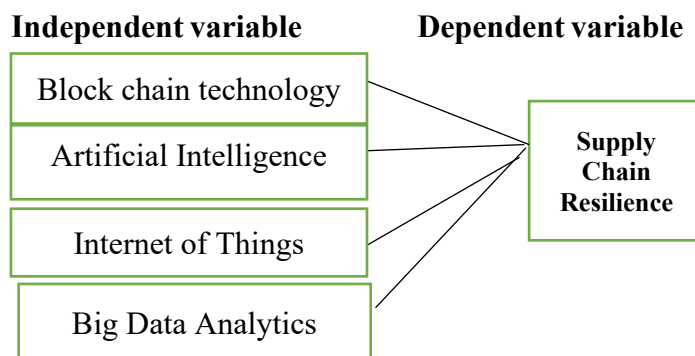


Figure 1: Conceptual framework for the study
Source: Author's Conceptualization, (2025)

II. METHODOLOGY

The study used mixed method research design to examine the effect of digital transformation technologies on supply chain resilience of Nestle Nigeria plc.

Method of Data Collection

The paper used primary data with 200 questionnaires for respondents from both junior and senior staffs using stratified random sampling techniques (supply chain management, production department, sales department and Information technology department) and in-depth interview with stakeholders (supply chain managers, information technology professionals) using purposive sampling techniques to gather qualitative insights and secondary data source include industry annual reports and sustainability on digital transformation trends in supply chains was employed.

Serial no	Department	Proportion	Sample
1	Supply chain management	40%	78
2	Production	30%	63
3	Sales	20%	45
4	Information technology	10%	22
5	Total	100	200

Method of data Analysis

The method of data analysis used for the study is inferential data analysis techniques. The Principal Component Analysis (PCA) was used for objective one, Pearson Product Moment Correlation (PPMC) was used objective two and Multiple regression analysis was used for objective three using Statistical Package for Social Sciences (SPSS) in order to ascertain the contribution of each explanatory variable to the supply chain resilience.

III. RESULTS AND DISCUSSION

TABLE 1: Principal Component Analysis of the Digital Transformation on Supply Chain operation
Eigenvalues: (Sum = 4, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative proportion
1	1.840641	0.845333	0.4602	1.840641	0.4602
2	0.995308	0.280845	0.2488	2.835949	0.7090
3.	0.714463	0.264875	0.1786	3.550412	0.8876
4	0.449588	---	0.1124	4.000000	1.0000

Source: Author's Computation, 2025

The results of study revealed the effect of digital transformation technologies on supply chain operations used Principal Component Analysis (PCA). The Table showed the Principal Component Analysis (PCA) on digital transformation components that capture the most variance in the data. PCA transform the original variables (block chain technology, artificial intelligence, internet of things and big data analytics) into a smaller set of components that capture the most variance in the data. Each component or Principal Component (PC) is a linear combination of the original variables, with the aim of explaining the maximum possible variation in the dataset. The eigenvalues in the PCA output represent the amount of variance explained by each principal component. In this case, four components are extracted, and their eigenvalues sum up to 4, which is equal to the number of variables. The first principal component (PC 1) explains the largest portion of the variance, about 46.02%, followed by PC 2, which explains an additional 24.88%. Together, these two components account for 70.90% of the variance, meaning that they are captured most of the information from the original data. The remaining components, PC 3 and PC 4, explain much less variance, suggesting that they add less important information. The cumulative proportion of variance explained how much of the data's variability is retained as more components are included. PC 1 and PC 2 together explain the majority of the variance (70.90%), indicating that a two-dimensional representation of the data is sufficient to capture the essential patterns in digital transformation. The contributions of PC 3 and PC 4 are much smaller (17.86% and 11.24% respectively), so these components are less critical in understanding the overall variation in the data.

The relationship between digital transformation technologies and Supply chain efficiency. The Pearson product-moment correlation coefficients in the table above provide insights into the strength and direction of the relationship between various aspects of digital transformation and supply chain efficiency. The block chain technology has high correlation coefficient of 0.927 indicates a very strong positive relationship between overall block chain technology usage and supply efficiency. This suggests that as block chain technology adoption in the selected firm increases, the supply chain efficiency is also increasing. The artificial intelligence high correlation coefficient of 0.863 indicates a very strong positive relationship between overall artificial intelligence usage and supply chain efficiency. This suggests that as artificial intelligence adoption in selected firm increases, the supply chain transparency is also increasing. The application of internet of things correlation coefficient of 0.754 indicates a

strong positive relationship between internet of things and supply chain efficiency. This suggests that increased application of internet of things in Nestle Nigeria Plc contributes to more increase in supply chain efficiency. The big data analytics correlation coefficient of 0.879 indicates a very strong positive relationship between big data analytics and supply chain efficiency, and statistically significant. Therefore, there is a significant relationship between digital transformation technologies and supply chain efficiency.

TABLE 2: The Pearson Correlation Results of the relationship between digital transformation technology and supply chain efficiency.

Variables	Correlation coefficient	Probability value	Remark
Block chain technology	0.927**	0.000	Significant
Artificial Intelligence	0.863***	0.000	Significant
Internet of Things	0.754***	0.000	Significant
Big Data Analytics	0.879**	0.000	Significant

Source: Source: Author's Computation, 2025

* = 10% significant

** =5% significant

*** = 1%

TABLE 3. Regression analysis on the extent to which digital transformation influence supply chain resilience

Variables	Coefficient	Std. Error	t-statistics	Prob.
C	0.758665	0.470797	1.611449	0.0000
BC	0.722245	1.406946	0.513342	0.0000
AI	1.674547	1.302993	2.285154	0.0007
IoT	0.698088	0.564682	1.236249	0.0017
BDA	1.144911	1.215193	0.942164	0.0005

R- squared	0.751339	Mean dependent var	12.40522
Adjusted R-squared	0.620982	S.D dependent var	10.76625
S.E of regression	0.478338	Akaike info criterion	4.695168
Sum of squared resident	26.54160	Schwarz criterion	5.222907
Log likelihood	-81.18863	Hannan -Quinn criterion	4.552689
F- statistics	12.37325	Durbin- Watson statistics	2.586144
Prob(F- Statistics)	0.000003		

Source: Author's Computation, 2025

The regression analysis in Table 3 provides insights into how different aspects of digital transformation technologies enhance supply chain resilience. Digital transformation technology coefficient is 0.722245 with a p-value of .0000, suggesting that the digital transformation technology has a reliable and statistically significant effect on the supply chain resilience, Artificial Intelligence coefficient is 1.674547 with a p-value of .0007 and a standardized coefficient. This significant positive relationship indicates that a well-adopted artificial intelligence enhances supply chain resilience. Internet of Things, the coefficient is 0.698088 with a p-value of .0017. This positive relationship suggests that internet of things applications is important, and its presence helps selected firm, thereby enhancing supply chain resilience. Big Data Analytics coefficient is 1.144911 with a p-value of .0005, indicating a significant positive impact. This suggests that big data analytics application promotes supply chain traceability, and thereby

helps the selected firm. The implication of this is that digital transformation has significant effect on enhancing supply chain traceability. Due to this result, the null hypothesis is rejected while the alternative hypothesis is accepted. That digital transformation technology has significant effect in enhancing supply chain resilience. The R Square of .751 indicates a very strong relationship between the predictors (block chain technology, artificial intelligence, internet of things and big data analytics) and the supply chain traceability. The R² value of .621 suggests that 62.1% of the variability in the supply chain traceability can be explained by the independent variables in the model. Block chain technology coefficient is 0.722245 with a p-value of .0000, suggesting that the block chain technology has a reliable and statistically significant effect on the supply chain resilience. Artificial Intelligence coefficient is 1.674547 with a p-value of .0007 and a standardized coefficient. This significant positive relationship indicates that a well-adopted artificial intelligence enhances supply traceability. Internet of Things, the coefficient is 0.698088 with a p-value of .0017. This positive relationship suggests that internet of things applications is important, and its presence helps the selected firm, thereby enhancing supply chain resilience. Big Data Analytics coefficient is 1.144911 with a p-value of .0005, indicating a significant positive impact. This suggests that big data analytics application promotes supply chain resilience, and thereby helps selected firm. The implication of this is that digital transformation technology has significant effect on supply chain resilience.

IV. CONCLUSION

Based on the summary of findings of this study, it was concluded that; Block chain technology, artificial intelligence, internet of thing and big data analytics are the digital transformation technologies enhanced supply chain operation. All the variables (block chain technology, artificial intelligence, internet of things and big data analytics have positive relationship with supply chain operation, efficiency, transparency, traceability and resilience.

Block chain technology, artificial intelligence, internet of things and big data analytics have positive significant influence in enhancing supply chain resilience. The study recommended based on the findings of the analysis regarding the impact of digital transformation technology on supply chain transparency and traceability, the following recommendations are proposed: For firms, the results show that digital transformation should be undertaken strategically, not only as a tool for operational efficiency but also as a resilience-building mechanism.

Digital technologies, especially block chain technology should be adopted to increase supply chain transparency, traceability, and businesses must balance the power dynamics in the supply chain operation to prevent becoming overly dependent on important partners.

In order to maximize the benefits of resilience, asset-intensive firms may need to combine digitalization with structural flexibility measures, while labor-intensive and technology-intensive firms should concentrate on digital tools that optimize workforce coordination and innovation-driven processes. Block chain technology and artificial intelligence

should be adopted most by food and beverages firms in enhancing its supply chain resilience, and this should follow with the adoption of internet of things and big data analytics.

The management of the firms should invest more on research and development on digital transformation as this will go a long way in improving the digital transformation technologies, thereby, enhancing supply chain resilience.

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