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Barriers and Enablers to Smart Logistics System Development in Nigeria's Supply Chain Industry

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Abstract: The paper has analysed the challenges and opportunities to the development of smart logistics systems in the Nigerian supply chain sector, particularly technology, financial, organisational, regulatory and infrastructural forces. The methodological approach used was a quantitative methodology, where data were gathered using a structured questionnaire among logistics and supply chain companies that are based in Nigeria. The survey population was developed with 520 logistics and supply chain professionals, out of which a sample of 226 respondents was identified and studied. The multiple regression analysis was used to analyze the effect of the independent variables on the development of smart logistics systems. The results demonstrated that the regression model was statistically significant and described a significant percentage of the change in the development of the smart logistics system. The technological factors and organisational factors proved to be the most predictive ones, meaning that digital readiness, system integration, management commitment, and employee competence are the key factors that facilitate the adoption of smart logistics. Significant positive effects were also observed to be exerted by financial aspects, regulatory and policy assistance, as well as infrastructure and environmental aspects, albeit to a lower degree. The paper concludes that the development of a smart logistics system in Nigeria is a multidimensional process that needs harmonisation of internal organisational capabilities with favourable external environmental conditions. The paper suggests more investment in digital infrastructure, capacity development, favourable regulatory environments, better access to finance, and infrastructural growth to positively affect the adoption of the smart logistics system in the supply chain sector in Nigeria.

Keywords: *Smart logistics system, supply chain industry, digital transformation, logistics innovation, Nigeria*.

Introduction

The pace of proliferation of digital technologies in the global business landscape has tremendously changed the way companies design and operate their business operations (Turban et al., 2021). Over the past few years, smart technologies have started playing a bigger role in the logistics and supply chain processes aimed at enhancing their efficiency, visibility, and coordination within the distribution networks (Ding et al., 2021). The Internet of Things, artificial intelligence, and data analytics, among others, have been used to complement decision making and operational control in logistics systems and provide the possibility of tracking goods in real time and automating the processes (Helo & Thai, 2024). In the very competitive industries, companies are currently relying on these technologies to plan logistics optimally, minimise delivery time, and react efficiently to the market demand (Hofmann & Osterwalder, 2017).

In the supply chain sector, smart logistics systems have gained a critical role in the management of the complex flows of goods and information. Sensor-based tracking systems, automated warehousing systems, and intelligent routing platforms are the technologies that are becoming more and more implemented to improve the efficiency of logistics and the quality of provided services (Pan & Liu, 2021; Torchio, 2023). Shamsuddoha et al. (2025) mentioned that digital logistics solutions such as machine learning applications, routing systems based on algorithms, and intelligent logistics platforms are used to enhance coordination and anticipate disruptions in supply chain networks. The technologies allow companies to predict operational problems and change logistics strategies according to the dynamic nature of the operating environment.

However, the performance of logistics and effectiveness of the supply chain have been over time found to be mostly dependent on the capability of the firms to build up systems that aid in the right passage of information and the ability to make decisions in time. Nevertheless, the patterns in the logistics requirements can be frequently unpredictable because of features like infrastructural limitations, market fluctuations, and environmental unpredictability (Orji et al., 2019). Feng and Ye (2021) contended that the implementation of intelligent technologies improves organisational learning and operational intelligence, as it allows for the data to be automatically processed and makes informed decisions. This enhancement can enable the firms to discover the underlying inefficiencies in the logistics processes and predict logistics performance more precisely. By using intelligent logistics, companies are able to enhance the alignment of supply chain participants with each other and enhance their responsiveness to demand and distribution dynamics (Jackson et al., 2024).

Irrespective of these benefits, companies that are in the supply chain market in Nigeria still struggle to come up with intelligent logistics models. The logistics organisations are under constant pressure to address the need to satisfy the customers by responding

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to the infrastructural constraints, regulatory constraints, and competitive pressures (Rose et al., 2016). The poor integration of systems, inaccurate logistics planning, and ad hoc adoption of digital solutions have remained issues impacting logistics performance throughout the industry (Caliskan et al., 2025). Despite the rising trend of the adoption of smart logistics technologies in recent years, little has been done to analyse the enabling factors and constraining factors that inform the development of the smart logistics systems in Nigeria.

The previous empirical research has mostly concentrated on the consequences of digital technologies instead of explaining the underlying obstacles and facilitators to the development of smart logistics systems. As an example, Du et al. (2025) analysed how digital technologies could affect customer satisfaction and discovered that intelligent service tools did a great job in enhancing customer experience. Toor et al. (2024) explored the role of predictive analytics in improving the performance of supply chains, whereas Olanrewaju et al. (2021) explored the association between the efficiency of the logistics and customer satisfaction. Nonetheless, little has been done with regard to the combined impact of technological, financial, organisational, regulatory, and infrastructural aspects on the emergence of smart logistics systems in the Nigerian supply chain setting. Such a literature gap implies the need to conduct an empirical study on pressure and facilitators of the development of the smart logistics system in the supply chain sector of Nigeria.

2. Literature Review

Theoretical Foundation

Technology Organisation Environment Framework (TOE).

In 1990, Tornatzky and Fleischer came up with the Technology Organisation Environment framework to describe how organisations adopt and implement technological innovations. According to the framework, three contexts, which are interdependent, are found to have an impact on the decisions of technology adoption, and they are, namely, the technological context, organisational context, and the environmental context. The application of the TOE framework to information systems adoption, digital transformation and supply chain innovation has had extensive application in research due to the capability of focusing on the external and internal factors influencing organisational choices (Tornatzky and Fleischer, 1990).

The technological context is defined as the pool of technologies to be used by the firm and encompasses aspects like technological preparedness, compatibility and complexity. In this context, with regard to the development of smart logistics systems, clarifies the impact of the presence of digital infrastructure, logistics software, and data analytics tools on adoption decisions. Research has revealed that companies that have access to sound information and communication technology infrastructure are likely to implement smart logistics systems due to the fact that technologies increase real-time visibility and coordination in supply chains (Helo & Thai, 2024; Du et al., 2025). On the other hand, low technological development and integration of systems serve as a hindrance to the growth of smart logistics systems, especially in the emerging economies.

Organisational context dwells on the specifics of firms, like management support, organisational culture, and the competence and financial capability of the employees. This element of the TOE framework lends theory on the organisational and financial variables considered within the framework of this research. According to the previous studies, top management commitment is a key factor in facilitating technology adoption through resource distribution and strategic priorities towards innovation (Jackson et al., 2024). Besides that, the presence of qualified staff improves the efficient utilisation of smart logistics technology by making sure that digital systems are put into place and sustained accordingly. Financial ability also defines the ability of firms to invest in the latest logistics technologies and maintain long-term digital transformation projects (Toor et al., 2024).

The environmental context takes into consideration external conditions that affect the decisions made by organizations such as government regulations, industry structure, competition pressure and availability of infrastructure. The elements of the environment that have a major impact on the development of the smart logistics systems in the Nigerian supply chain market include uncertainty in regulations, poor transport infrastructure and lack of a reliable power supply. Research shows that favourable government policies and stable regulatory frameworks are motivating business organisations to invest in digital logistics solutions through alleviating uncertainty and the perceived risk (International Trade Administration, 2025; Noiki et al., 2025). In like manner, physical infrastructure will be improved, which increases the viability of the implementation of the smart logistics system by contributing to real-time connectivity and reliability of operations.

The TOE framework is especially adequate in this research, as it offers a holistic description of the way in which technological, organizational and environmental factors interplay and shape the development of smart logistics systems. By being squarely in line with the aspects of technological aspects, financial aspects, organisational aspects, regulatory and policy aspects and infrastructure and environmental aspects, the framework provides a solid theoretical framework with which to analyse the obstacles and facilitators to the development of smart logistics systems in the Nigerian supply chain sector.

Diffusion of Innovation Theory.

Diffusion of Innovation theory was initially postulated by Rogers in 1962 and was later improved in later editions of his work. The theory describes the process of the spreading of new ideas, technologies and innovations in a social system. Rogers claims that five major attributes determine the uptake of an innovation and they include relative advantage, compatibility, complexity, trialability and observability (Rogers, 2003). The attributes determine the perception of a potential adopters on an innovation and the diffusion rate within organizations.

The Diffusion of Innovation theory can offer an understanding of how logistics companies can analyze and implement smart technologies in the context of the development of the smart logistics system. The relative advantage can be defined as the extent to which the smart logistics systems are felt to be better than the traditional logistics practices. When firms realize the perceived benefits of using smart logistics solutions, they will adopt them, especially when they see that the technology will make them gain better efficiency, decreased delivery time, and visibility of the supply chain (Du et al., 2025). The compatibility is connected to how compatible smart logistics systems are with the current logistics processes and organizational values. Consistent with the integration of digital logistics solutions with existing operations,

the chance of adoption increases. Complexity is how the innovation is perceived to be. Employees and managers at firms with low levels of digital skills might be opposed to initiatives of implementing smart logistics technologies because they are viewed to be too complicated. This complexity can also serve as an obstacle to adoption particularly in the developing economies where technological literacy might not be even distributed (Noiki et al., 2025). Trialability and observability also affect the decisions on adoption since it enables firms to test smart logistics solutions and see their positive impact before adopting it on a large scale.

The Theory of Diffusion of Innovation also highlights the importance of organizational as well as environmental factors in the adoption behavior. The rate of adoption of smart logistics technologies is influenced by the management attitudes toward innovation, the readiness of employees and their organizational culture. Perceived risk and cost to adoption is affected by financial aspects and hence diffuses. Moreover, the regulatory favor and the industry conventions influence the speed of the transfer of smart logistics innovations in the logistics industry. The industry has supporting policies and observable success stories that promote imitation and increased use of smart logistics systems (International Trade Administration, 2025). The use of the Diffusion of Innovation theory to the current study is the fact that it can be used to analyze the disparity in the degree of smart logistics system development among the logistics companies in Nigeria. Although there are companies that become early adopters of smart logistics technologies, some companies still lag behind because of perceived barriers and in-enabling conditions. Through this theory, this study supports how the perceptions of smart logistics technologies relate to organizational and environmental forces that affect the adoption behavior in the supply chain sector.

Smart Logistics System Development Idea.

The strategic use of digital technologies to enhance logistics and supply chain performance and management is called smart logistics system development (Shee et al., 2021). It is a combination of smart systems that complement real-time data gathering, automated decision support and efficient information exchange between supply chain stakeholders (Giannakis & Louis, 2016). By such systems, companies can now operate better and manage inventory flows, transportation activities, warehousing operations and deliveries more precisely and efficiently. The Internet of Things, artificial intelligence and data analytics are some of the technologies that are central to providing smart logistics opportunities through visibility and control of logistics networks (Helo & Thai, 2024).

According to existing literature, smart logistics systems improve operational performance through the minimisation of uncertainty and enhancement of coordination in the supply chains. Du et al. (2025) described that smart logistics systems enable firms to predict and optimise logistics operations with the help of data-informed insights and predictive analytics. This perception is consistent with the prior research studies that underscore the fact that digital integration enhances openness and sensitivity in logistics operations. In emerging economies, the creation of smart logistics systems is becoming a strategic reaction to the inefficiencies of traditional logistics systems (i.e. manual tracking, inadequate coordination and slow flow of information) (Sumbal et al., 2024). Within the context of Nigeria, researchers claim that smart logistics leads to the possibility of solving the long term issues of infrastructure deficiencies and the lack of operational efficiency. The scope of development of the smart logistics system, however, remains heavily determined by the presence of facilitating conditions in the business environment as well as firms to deal with structural obstacles that limit digital transformation (Noiki et al., 2025; International Trade Administration, 2025).

Technological Factors

Technological reasons are one of the aspects inherent in the development of smart logistics. These aspects are connected with the availability, reliability and compatibility of digital technologies needed to facilitate intelligent logistics performances (Ding et al., 2021). The supply chain participants need to have sufficient information and communication technology infrastructure that facilitates real time data sharing and integration of systems. In most of the developing economies, such as Nigeria, unstable digital infrastructure has been cited as a significant obstacle to the development of smart logistics. The inability to effectively implement advanced technologies in logistics companies is caused by poor internet connection, low system interoperability and low digital platforms.

Various researches underline technological preparedness as the key factor of success of smart logistics programs. According to Shamsuddoha et al. (2025), the successful implementation of machine learning applications, systems of sensor monitoring and smart routing tools is highly dependent on technological competency of logistics companies. In the case companies do not have up-to-date logistics software and well-developed data management systems, the development of smart logistics is still insufficient. On the other hand, those companies with stable digital infrastructure and technologies that can work with them can be more likely to adopt smart logistics (Pauzuoliene et al., 2024). The increased use of cloud computing environment and mobile based logistics applications in Nigeria implies that technology can also be enablers in cases where companies invest in relevant level of digital capabilities and systems integration (Noiki et al., 2025).

Financial Factors

There are significant financial variables that determine the capability of logistics firms to build smarter logistics. Smart logistics technologies acquisition, implementation and maintenance are costly and thus may be difficult to accomplish by companies that have limited resources at their disposal (Pauzuoliene et al., 2024). The high cost of implementation, inability to access finance and uncertainty of returns on investments have been extensively cited as major financial challenges to the adoption of smart logistics, especially among small and medium-sized logistics companies (Noiki et al., 2025).

There is empirical data that suggests that companies that have a greater financial base tend to invest in initiatives of digitalising logistics. Toor et al. (2024) suggested that sufficient financial resources can help companies to obtain sophisticated analytics tools, automation systems and digital platforms that improve logistics performance. Access to cheap financing remains a challenge in the application of smart logistics solutions by many logistics companies in the Nigerian context. But these constraints can be tremendously decreased through the financial support packages like the government incentives, investment by the private sector and generous lending conditions (Beck, 2007). Funding limitations of SMEs in the less developed nations: Evidence, determinants and solutions. Funding business-based innovation to enhance entrepreneurship. Reducing financial obstacles leads to a

greater willingness of firms to invest in long-term digitalisation and the development of smart logistics systems (Noiki et al., 2025).

Organizational Factors

Organisational factors are internal characteristics of firms that have an impact on the development of smart logistics systems. These are management commitment, workers' skills, culture and the willingness of the organisation to technological change. One of the greatest organisational obstacles would be resistance to change, especially in companies that rely a lot on the conventional forms of logistics. Smart logistics technologies can be considered complex or disruptive by the employees that delays the processes of adoption and implementation (Noiki et al., 2025; Jackson et al., 2024).

The smart development of logistics requires organisational learning and innovation capability. Jackson et al. (2024) highlighted that companies with permissive leadership and a culture of experimentation and constant improvement have more chances to adopt digital logistics solutions. Management support is at the centre of resource allocation, the establishment of strategic priorities and encouraging employees to work with new technologies (Appelbaum et al., 1998). Organisational preparedness is also improved by the presence of talented human resources, as the effective implementation of smart logistics systems is guaranteed. Organisational factors become not barriers to enablers of smart logistics system development when the companies train their employees and focus on the creation of an innovation culture (Noiki et al., 2025).

Policy and Regulatory Environment.

The institutional environment that has developed the smart logistics systems is influenced by regulatory and policy factors. Unpredictable policies, ineffective implementation of policies and a lack of proper guidelines on the development of digital logistics may serve as inhibitors of the development of smart logistics (Caliskan et al., 2025). Regulatory regimes on data security and electronic transactions and technology specifications are also unclear or unstable, which may make logistics companies unwilling to invest in smart technologies (Noiki et al., 2025). Researchers emphasise that favourable governmental policies contribute to the digitalisation of logistics. Certainty in regulations builds confidence in firms and motivates them to invest in technology that is led by logistics solutions. The development of a smart logistics system can be much facilitated by policies that encourage the development of digital infrastructure, preserve privacy and enable standardisation of logistics operations (McDonald, 2024). Regulatory changes that promote the digital revolution and innovation in the logistics sector are necessary in Nigeria to develop a business climate facilitating the adoption and development of smart logistics (Noiki et al., 2025).

Infrastructural and natural environmental conditions.

Infrastructure and environmental conditions are external conditions that affect the development of a smart logistics system. Ineffective transport infrastructure, unstable power supply and endemic security problems have been continuously named as key challenges to effective logistics processes in Nigeria (Olalekan, 2025). Such structural limitations constrain the efficacy of smart logistics technologies by disrupting real time connectivity and diminishing elements of operational dependability (Noiki et al., 2025). Environmental factors are very sensitive to the patterns of logistics demand and the efficiency of operations. Road networks, port and energy infrastructure is improved, and this is beneficial in making smart logistics systems possible. An adequate infrastructure facilitates the application of smart tracking technologies and automated logistics routines and enhances the quality of services (Shee et al., 2021). An efficient smart logistics development demands environmental stability and efficient urban planning, which also enhances the operational environment. Infrastructure and environmental issues are also important to deal with to facilitate the development of smart logistics systems in the supply chain sector in Nigeria (Noiki et al., 2025).

Empirical Review

Caliskan et al. (2025) analysed the implications of impediments and obstacles regarding the implementation of the logistics 4.0 technology in the environment of rapid changes in digital space. The rationale behind the research is the mounting pressure on logistics companies to modernise their operations in the face of the ongoing technological improvements. The authors evaluated the impact of structural and organisational barriers on logistics efficiency and the digital transformation through a mixed methods approach, which implies that they combined survey results with modelling methods. It was found that the lack of infrastructural facilities, the lack of professional staff, the high cost of implementation, and the opposition to organisational change are major factors that reduce the pace of the adoption of Logistics 4.0 technologies. The paper has also noted that big companies were in a better position to embrace leading technologies in logistics because of their greater financial and technological capabilities, whereas small companies experienced even more restricted conditions. The authors also came to the conclusion that despite the significant barriers to the development of Logistics 4.0, strategic investments in research and development, training of the workforce, and infrastructure can overcome these barriers and improve their implementation in the digitally changing logistics landscape (Caliskan et al., 2025).

In their study, Sumbal et al. (2024) have explored the logistics performance systems in a developing economy by analysing the logistics sector in Pakistan in terms of the World Bank Logistics Performance Index. The research aimed at the realisation of the impact of logistics performance on the effectiveness of the China-Pakistan Economic Corridor within the framework of the Belt and Road Initiative of China. The authors used a qualitative research design, analysed the data of the Logistics Performance Index, policy documents, news reports, and organisational sources and followed a case study approach. The results indicated that the ineffective infrastructure, inefficient customs systems and international shipments have been major limitations to logistics performance in developing economies. Nevertheless, it is notwithstanding these constraints that enhancements in the performance of logistics were observed to play a significant role in reducing trade costs and increasing the efficiency of the corridors. The research has also observed that the challenges after the COVID period increased existing barriers. The authors came to the conclusion that to maximise the economic returns of the major trade corridors in developing economies, it is important to strengthen the logistics performance systems through digitalisation, upgrades of the infrastructure, and reformative policy (Sumbal et al., 2024).

Pauzuoliene et al. (2024) discussed the concept of smart technologies in the logistics industry and researched the advantages and drawbacks of their adoption. The research was based on a quantitative methodology, and a survey penetration was conducted with the representatives of the logistics companies in Lithuania. The results showed that smart technologies like route optimisation tools, real-time tracking systems and document digitisation are becoming important to the logistics companies as they seek to enhance operational efficiency, cut costs and improve service quality. Nevertheless, the study found initial high investment costs, system compatibility, and skill gaps as the greatest impediments towards successful implementation, especially to small and medium-sized enterprises. The authors have found that despite the intensive benefits of operational and competitive advantages of smart technologies, there is a need to respond to the financial, technical, and human resource obstacles to experience a more comprehensive and sustainable integration in the dynamic logistics market that is dynamic (Pauzuoliene et al., 2024).

The theoretical discussion presented in the article by Appelbaum et al. (1998) gave a background on strategic organisational change and how it relates to leadership, learning, motivation, and productivity. The authors synthesised empirical and theoretical findings through the conceptual and theoretical review in order to describe the role of strategic organisational change in the dynamics of the internal organisation. The paper has highlighted that leadership is facilitative during the change process as it enhances organisational learning and employee motivation. The results indicated that organisational cultures that promote involvement, lifelong learning, and conducive management frameworks would become more willing to realise productivity gains in the transformation programs. The authors concluded that leadership development, learning processes and employee motivation are neglected and therefore are likely to result in implementation failure, whereas when integrated, they have a long lasting organizational change. This view is still applicable in considering the organisational preparedness for implementing smart logistics systems (Appelbaum et al., 1998).

McDonald (2024) observed the interplay between technological innovation and the development of the logistics of the rapidly developing economy of Vietnam. The study revealed the motivators and limitations that affect technology adoption in the logistics industry in Vietnam using a qualitative review of industry data, trends and case examples. The results revealed that the growth of the economy and rising volumes of trade have promoted the demand for efficient logistics services; the infrastructural gaps and the shortage of skills remain the obstacles to performance. The Internet of Things, artificial intelligence, and blockchain were technologies that were mentioned as the enablers of efficiency, sustainability, and competitiveness. Nevertheless, the rates of adoption were quite different in regard to the size of the firms and organisational preparedness. The researchers found that logistics companies in the developing economies must adopt technological innovation to survive and grow as long as the implementation strategies are in line with organisational capacities and environmental conditions (McDonald, 2024).

Ahmed (2025) also investigated the effect of infrastructural shortages on the efficacy of logistics in the Nigerian setting. Based on the exploratory research method, the paper looked at the effects of bad road networks, untrustworthy power supply, and poor storage facilities on the logistics performance. The result showed that infrastructural issues will play a role in creating frequent delivery delays, higher operational costs, and low service reliability in the supply chain industry of Nigeria. The paper has stressed that physical and energy infrastructure is very crucial in determining the efficiency of logistics, especially in developing economies whose environmental conditions are still volatile. The author came to the conclusion that infrastructural deficiencies are important issues to address to enhance the logistics performance and to facilitate the successful implementation of advanced logistics systems in Nigeria (Ahmed, 2025).

Methodology

The research design used in this study was a quantitative research design, where the researcher sought to investigate the barriers and facilitators to the development of a smart logistics system in the Nigerian supply chain industry. Data on the respondents were collected through a cross-sectional survey method, which allowed the assessment of the role of technological, financial, organisational, regulatory and infrastructural factors in the development of smart logistics systems empirically, once only at a single point in time. The study population was 250 logistics and supply chain companies based in big commercial centres in Nigeria, including third-party logistics service providers, freight forwarding and distribution firms. The unit of analysis was the logistics managers, supervisors and operational staff directly involved in the logistics planning, warehousing and transportation management. A sample size of 156 respondents was selected using a formula of sample determination by Krejcie and Morgan (1970) to make the sample representative and statistically reliable.

The structured questionnaire was used to collect data about the perception of the respondents on the independent variables, technological, financial, organisational, regulatory and infrastructural factors and the dependent variable, which was the development of the smart logistics system. Everything was measured on five points Likert scale of strongly disagree to strongly agree. The pretest involved the questionnaire to make it clear and content valid. To analyse the data, the multiple regression analysis was used to investigate the individual and synergistic effects of the independent variables on developing the smart logistics system. The model specification of the multiple regression is presented in the following form:

SLS= b0 + b1TF + b2FF + b3OF + b4RP + b5IEF + e

Where:

SLS = Smart Logistics System Development (dependent variable)

TF = Technological Factors

FF = Financial Factors

OF = Organisational Factors

RP = Policy and Regulatory Factors.

IEF = Infrastructure and Environmental Factors.

b0 = Intercept

b1... b5 = Regression coefficients of independent variables.

e = Error term

Results and Discussion

Reliability Analysis

Cronbach's alpha was used to test the reliability of the instrument to ensure internal consistency. All the constructs of the study, technological factors, financial factors, organisational factors, regulatory and policy factors, infrastructure and environmental factors, and the development of smart logistics systems included four items. Table 1 gives the Cronbach alpha values of every variable.

Table 1: Study Constructs Reliability.

Variable	Number of Items	Cronbach's Alpha
Technological Factors (TF)	4	0.821
Financial Factors (FF)	4	0.834
Organizational Factors (OF)	4	0.812
Regulatory factors (RF) Regulatory Policy Factors (RPC)	4	0.807
Infrastructure and Environmental Factors (IEF)	4	0.819
Smart Logistics System Development (SLS).	4	0.828

Cronbach's alpha was used to determine the reliability of the research instrument in order to establish the internal consistency of all the constructs. All variables, technological factors, financial factors, organisational factors, regulatory and policy factors, infrastructure and environmental factors, and smart logistics system development were rated using four items. The reliability test showed that there was high internal consistency in all the constructs, where the Cronbach alpha value was greater than the acceptable value of 0.7. This validates the fact that the tool is valid and applicable in assessing perceptions on variables that affect the development of smart logistics systems. The same remarks can be made about the significance of the reliability of the employed instrument, as the works by Jackson et al. (2024) and Noiki et al. (2025) have also stressed that valid and interpretable outcomes in technology adoption and supply chain innovation studies can only be achieved with the help of reliable measurement tools.

Descriptive Statistics

Descriptive statistics were also calculated to get the perception of the respondents on the independent and dependent variables. Table 2 shows the average and the standard deviation of each construct.

Table 2: The Descriptive Statistics of Variables.

Variable	Mean	Standard Deviation
Technological Factors (TF)	4.12	0.58
Financial Factors (FF)	3.95	0.61
Organisational Factors (OF)	4.05	0.55
Reference Factors (RP) Regulatory and Policy.	3.88	0.63
Infrastructure and Environmental Factors (IEF)	3.90	0.60
Smart Development of Logistics System (SLS).	4.08	0.57

The findings reveal that the respondents tended to agree that the independent variables are enablers or inhibitors of the development of the smart logistics system. This is indicated by the high mean of the variables of technological, organizational and smart logistics system development, which indicates that the respondents view technology readiness, organisational support and system adoption as very important enablers. Financial and regulatory and infrastructural factors scored slightly lower on mean scores, meaning there is some possible limitation in resources, clarity of policies, and infrastructural support. Such results align with the works by Du et al. (2025) and Helo and Thai (2024), who emphasised the role of organisational support and technological preparedness in the successful adoption of digital logistics.

Multiple Regression Analysis.

The role played by technological, financial, organizational, regulatory and infrastructural factors in the development of the smart logistics system was determined through a multiple regression analysis. The regression results are shown in table 3.

Table 3: Multiple Regression Analysis (Smart Logistics System Development)

Independent Variable	Beta (β)	t-value	p-value
Technological Factors (TF)	0.312	3.954	0.000
Financial Factors (FF)	0.268	3.112	0.002
Organizational Factors (OF)	0.295	3.645	0.001
Regulatory and Policy Factors (RP)	0.214	2.874	0.004
Infrastructure and Environmental Factors (IEF)	0.227	2.965	0.000
$R^2 = 0.652$, $F(5, 150) = 56.32$, $p = 0.000$			

The multiple regression equation indicated that the five independent variables, which include technological, financial, organisational, regulatory, and infrastructural factors, were the ones that explained 65.2 per cent of the variance in the development of smart logistics systems in the supply chain industry in Nigeria. Such a high coefficient of determination exhibits a high ability of the model to predict. Moreover, at p = 0.000, the F-statistic was significant, which proves that the regression model is statistically appropriate to the data and can be used to investigate the impact that the chosen factors have on the adoption of the smart logistics system (Du et al., 2025; Noiki et al., 2025).

The positive and significant effect of the Technological Factors (TF) on the development of the smart logistics systems was observed in the form of the beta coefficient of 0.312 with p = 0.000. This observation shows that the more technologically prepared firms with a sound ICT framework and successful system integration tend to embrace smart logistics solutions. Accordingly, the null hypothesis that technological factors are not capable of making a significant difference to the development of a smart logistics system is rejected. Such a conclusion can be made in line with Du et al. (2025), who stressed that technology readiness and system integration are the key drivers of logistics innovation, and Helo and Thai (2024), who found that the use of advanced digital tools, including IoT, machine learning, and real-time tracking systems, can have a significant positive effect on operational efficiency in supply chains.

The financial factors (FF) also had a significant impact on the development of the smart logistics system; the beta is 0.268 and p = 0.002. This is to show that companies that have sufficient financial capabilities can invest in smart automation-based technologies, logistics, and digital platforms required to operate efficiently. H 0 the financial factors are thus rejected. This outcome corresponds to the results of Toor et al. (2024), who pointed out that financial capacity allows companies to break barriers to investments and maintain long-term transformations based on technologies. On the same note, Noiki et al. (2025) noted that funding is a major enabler to digital adoption in the logistics companies due to the resource-constrained environments which most logistics companies face.

It was found that Organisational Factors (OF) have a positive and significant effect on the development of smart logistics systems, and the beta coefficient and p are 0.295 and 0.001, respectively. This is indicative of the fact that management commitment, employee competence, and innovation oriented organizational culture are strong motivating factors towards the embracement of smart logistics technologies. The null hypothesis is rejected, which proves that organisational characteristics are important factors in adopting technologies. Jackson et al. (2024) postulated that the main elements of successful technology implementation in logistics are organisational preparedness, leadership facilitation, and the culture of continuous learning. Helo and Thai (2024) also stated that firms can use technological tools to achieve operational excellence when they have well-trained personnel and progressive leadership.

Policy Factors (RP) played a very significant positive role in the development of the smart logistics system, as it had a beta of 0.214 and a p = 0.004. When the regulatory frameworks are transparent, stable and enable operations relying on technology, a greater number of firms will switch to digital logistics solutions. Consequently, the null hypothesis that regulatory and policy conditions do not impact the development of a smart logistics system is rejected. The same conclusion is aligned with Noiki et al. (2025), who have emphasised the significance of regulatory transparency and governmental encouragement of the idea of logistics digitalisation. Moreover, the International Trade Administration (2025) also observed that efficient data security and technology adoption policy frameworks and standards foster investment in smart logistics solutions.

The Infrastructure and Environmental Factors (IEF) were also significant in affecting the development of the smart logistics system, with a beta coefficient of 0.227 and p = 0.003. Proper transport systems, good electricity supply, and consistent operations are some advantages that enhance the application and performance of smart logistics technologies. The null hypothesis on the infrastructural and environmental factors is therefore rejected. This is in line with the findings of Noiki et al. (2025), who noted that infrastructural enhancement, such as road networks, ICT, and city structure, is among the most important facilitators of the adoption of smarter logistics, especially in developing economies such as Nigeria.

Conclusion

This paper has analyzed the obstacles and opportunities to the development of smart logistics systems within the supply chain sector of the Nigeria business environment in terms of technological, financial, organizational, regulatory, and infrastructural. These results show that the five dimensions have a major impact on the adoption and development of smart logistics systems. Factors influencing it the most were the technological and organizational ones, as the emphasis was on the inner preparedness, digital skills, the dedication of the management, and the ability of the employees to competently implement the changes. Financial, regulatory and infrastructural factors, though not so

influential are still important in facilitating or limiting adoption. These findings prove that the development of smart logistics systems is a complex process and it requires the interactions between the internal organizational capacity and external environmental conditions.

The research highlights the fact that technology preparedness, including the availability of advanced ICT infrastructure, system integration, and electronic tools is a key determinant of improving the operational efficiency and responsiveness of logistics networks. The commitment of leadership, skills of employees, as well as culture that promotes innovation in the organization are also significant since they can make firms utilize technological solutions effectively. Financial capability guarantees the ability of firms to invest in the required tools and run long-term digital projects, and well-defined regulatory environments and favourable policies give an assurance to firms to implement novel logistics services. Lastly, real-time connectivity and operational continuity need to have adequate infrastructure and stable environmental conditions.

Study's Recommendations

It is based on these findings that a number of recommendations are offered.

a. To increase the efficiency of operations and system integration, logistics firms are advised to invest in technological infrastructure, such as cloud-based systems, automated routing systems, and smart trackers.

b. Second, organisations need to enhance capacity within the organisation through the creation of a culture of constant learning, offering staff members regular training as well as leadership engaging in the digital transformation efforts.

c. The financial issues would need to be handled with the help of strategic resource distribution, the possibility of public-private relations, and finding beneficial sources of funds to facilitate the implementation of smart logistics technologies.

d. Regulatory authorities and policymakers ought to create and implement coherent, explicit policies that can assist in adopting digital logistics and data protection, technology use, and operational regulations.

e. The infrastructure issues must be mitigated with the help of investments in transport infrastructure, ICT systems, and reliable power supply, so that the environmental conditions do not prevent the successful implementation of intelligent logistics systems.

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