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EFFECT OF INFRASTRUCTURE ON OPERATIONAL EFFICIENCY AND CUSTOMER SATISFACTION OF SMEs IN TRANS-BORDER TRADE IN SELECTED LGAs OF ADAMAWA STATE

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Abstract

This study examined the effect of infrastructure on the operational efficiency and customer satisfaction of small and medium-sized enterprises (SMEs) engaged in trans-border trade in selected local government areas of Adamawa State, Nigeria. Specifically, the study assessed the effect of infrastructure on the operational efficiency of SMEs and evaluated its influence on customer satisfaction. A descriptive and explanatory survey research design was adopted. The study covered SMEs engaged in trans-border trade in Mubi North, Mubi South, Fufore, and Toungo Local Government Areas. Using Cochran's sample size formula, a sample of 422 SMEs was selected. Data were collected through structured questionnaires administered to SME owners and managers. Out of the 422 questionnaires distributed, 399 valid responses were retained for analysis. The data were analysed using regression analysis with the aid of SPSS version 27. The findings revealed that infrastructure had a positive and statistically significant effect on the operational efficiency of SMEs, indicating that improved road networks, transportation facilities, border infrastructure, and storage facilities enhance business operations and resource utilisation. Similarly, infrastructure had a positive and statistically significant effect on customer satisfaction, suggesting that adequate infrastructure facilitates timely product delivery, improves product availability, and enhances service delivery. The study concluded that infrastructure is an important factor in improving operational efficiency and customer satisfaction among SMEs engaged in trans-border trade in Adamawa State. It recommended that federal, state, and local governments invest in the development and rehabilitation of road networks, transportation systems, border facilities, and storage infrastructure to reduce operational delays, improve service delivery, and strengthen SME competitiveness.

Keywords: *Infrastructure, operational efficiency, customer satisfaction, SMEs, trans-border trade, Adamawa State.*

Introduction

Trans-border trade, which involves the exchange of goods and services across national boundaries, plays a significant role in promoting the growth and development of small and medium-sized enterprises (SMEs) in Adamawa State, Nigeria, particularly because of the state's proximity to the Republic of Cameroon. Cross-border trading activities enable SMEs to access larger markets, attract new customers, increase sales, and participate in regional value chains. According to Mahdi and Rufai (2025), informal cross-border trade in agricultural produce, textiles, and manufactured goods constitutes an important component of Adamawa State's economy. However, the extent to which SMEs benefit from these opportunities depends partly on the availability and quality of infrastructure, including accessible road networks, electricity supply, storage facilities, and efficient border logistics. Inadequate infrastructure increases transportation costs, causes delays in the movement of goods, and limits the ability of SMEs to operate efficiently. As Musa et al. (2025) observed, infrastructural deficiencies in border communities constrain the smooth movement of goods and discourage the formalisation and expansion of cross-border business activities.

Infrastructure is particularly important in determining the operational efficiency of SMEs engaged in trans-border trade in selected local government areas of Adamawa State. Operational efficiency reflects the ability of enterprises to manage resources effectively, minimise operating costs, reduce delays, and ensure the timely movement and delivery of goods. Where transport networks are poorly developed, electricity supply is unreliable, and storage and logistics facilities are inadequate, SMEs are likely to experience increased operating expenses, product losses, prolonged delivery times, and disruptions in business activities. These challenges are particularly significant for traders dealing in perishable agricultural products and other goods that require timely transportation and proper storage. Olalekan (2025) emphasised the operational difficulties associated with inefficient trade processes, while Mahdi et al. (2025) highlighted the importance of infrastructure in supporting business activities in Adamawa State. Therefore, assessing the effect of infrastructure on the operational efficiency of SMEs is necessary to establish how improvements in transportation, electricity, storage, and border facilities can reduce transaction costs, improve resource utilisation, and strengthen the competitiveness of enterprises participating in trans-border trade.

Furthermore, infrastructure plays an important role in determining customer satisfaction among SMEs involved in trans-border trade in Adamawa State. Customer satisfaction depends on the ability of businesses to provide quality products at competitive prices, deliver goods promptly, and maintain reliable service standards. Inadequate roads, poor storage facilities, unreliable electricity, and inefficient logistics can result in delayed deliveries, increased product prices, and damage to goods, thereby weakening customer confidence and reducing the likelihood of repeat purchases. Hamzat (2023) noted that customs delays and infrastructural challenges can undermine customer satisfaction by increasing costs and extending delivery periods. Conversely, improved infrastructure can facilitate the timely movement of goods, preserve product quality, enhance service reliability, and enable SMEs to respond more effectively to customers' needs in both Nigerian and Cameroonian markets. Although Adamawa State's geographical location offers considerable opportunities for cross-border commerce, the extent to which SMEs translate these opportunities into improved customer experiences remains an important concern. Consequently, this study seeks to assess the effect of infrastructure on the operational efficiency of SMEs engaged in trans-border trade in selected local government areas of Adamawa State and evaluate how infrastructure influences customer satisfaction among these enterprises.

Small and Medium Enterprises (SMEs) are widely recognised as important contributors to economic growth, employment generation, and regional development, particularly in border communities where trans-border trade provides opportunities for business expansion and income generation. In Adamawa State, especially in Mubi North, Mubi South, Fufore, and Toungo Local Government Areas, SMEs participate actively in trading activities with the Republic of Cameroon. However, despite the economic opportunities associated with trans-border trade, many SMEs continue to experience poor operational efficiency and difficulties in satisfying customers due to inadequate infrastructure. Poor road networks, unreliable electricity supply, insufficient storage facilities, and inadequate transportation and logistics systems increase operating costs, delay the movement of goods, reduce productivity, and contribute to product deterioration, particularly among traders dealing in perishable commodities. These infrastructural deficiencies limit the ability of SMEs to utilise available resources effectively, maintain consistent business operations, and deliver goods to customers promptly. Consequently, the operational efficiency of SMEs remains constrained, while their capacity to meet customers' expectations regarding product quality, affordability, and timely delivery is adversely affected.

Furthermore, existing literature has established that infrastructural development is essential for facilitating cross-border trade and improving business performance. Lesser and Moisé (2009) observed that cross-border trade creates opportunities for SMEs to participate in regional commerce, although inadequate trade facilitation systems and high transaction costs can undermine their competitiveness. Similarly, González and Sorescu (2019) emphasised that barriers affecting the movement of goods across borders increase business costs and weaken the ability of SMEs to respond effectively to market demands. Despite these contributions, existing studies have largely examined trade facilitation, customs procedures, and general barriers to international trade, with limited empirical attention given to the specific effect of infrastructure on the operational efficiency and customer satisfaction of SMEs engaged

in trans-border trade in Adamawa State. Moreover, differences in geographical conditions, infrastructural development, and business environments make it difficult to generalise findings from other regions to the selected border communities. This creates a contextual and empirical gap regarding the extent to which infrastructure influences operational efficiency and customer satisfaction among SMEs in the study area. Therefore, this study seeks to address this gap by examining the effect of infrastructure on the operational efficiency and customer satisfaction of SMEs engaged in trans-border trade in selected Local Government Areas of Adamawa State, Nigeria.

This study was guided by the following research questions:

1. How does infrastructure influence the operational efficiency of SMEs engaged in trans-border trade?
2. How does infrastructure affect customer satisfaction among SMEs in trans-border trade?

The main objective of this study is to examine the effect of infrastructure on operational efficiency and customer satisfaction of SMEs in trans-border trade in selected LGAs of Adamawa State. The specific objectives are to:

1. assess the effect of infrastructure on the operational efficiency of SMEs engaged in trans-border trade in selected LGAs of Adamawa State;
2. evaluate how infrastructure influences customer satisfaction among SMEs engaged in trans-border trade in selected LGAs of Adamawa State.

The following hypotheses were formulated to guide to the study:

$H_0$1: Infrastructure has no significant effect on the operational efficiency of SMEs engaged in trans-border trade in selected LGAs of Adamawa State.

$H_0$2: Infrastructure has no significant effect on customer satisfaction among SMEs in selected LGAs of Adamawa State.

Literature Review

Infrastructure

Infrastructure refers to the physical and organizational facilities required for the effective functioning of an economy, including transportation networks, electricity supply, telecommunications, water systems, and storage facilities. Logistics, on the other hand, encompasses the planning, implementation, and management of the efficient movement and storage of goods, services, and information from the point of origin to the point of consumption. Adequate infrastructure enhances logistics performance by reducing transportation costs, minimizing delivery delays, and improving market accessibility. Conversely, poor infrastructure increases operational costs, disrupts supply chains, and limits the competitiveness of businesses, particularly in developing countries (World Bank, 2023; Rodrigue, 2020). OECD (2020) defines infrastructure as the system of public works in a country, state, or region, including roads, utility lines, and public buildings.

World Bank (2024) explains infrastructure in terms of essential services and systems, including transportation, energy, digital connectivity, water supply, and sanitation, which improve access to economic opportunities, enhance productivity, and support economic growth. Furthermore, improving infrastructure and logistics contributes significantly to sustainable local economic development by enhancing productivity, promoting employment, and strengthening regional connectivity. Investments in transport infrastructure, digital connectivity, and modern logistics facilities support agricultural commercialization, industrial development, and access to domestic and international markets.

Operational Efficiency

According to Tobi (2021), operational efficiency refers to the effective coordination and utilization of organizational resources, including human capital, financial resources, technology, and materials, to accomplish organizational objectives with minimal waste and reduced operating costs. Similarly, Salemcity and Okeke (2022) defined operational efficiency as the organization's ability to transform available inputs into quality outputs by adopting efficient production and administrative processes that

minimize time, cost, and resource wastage. In another perspective, Henry et al., (2023) described operational efficiency as the extent to which an organization effectively manages its operational activities to maximize productivity while maintaining quality and minimizing operational expenses. They noted that operational efficiency involves proper planning, effective coordination of employees, prudent utilization of organizational assets, and continuous evaluation of operational processes to eliminate inefficiencies. Gunasekaran, (2000) explained Operational efficiency as how effectively an SME utilizes its resources such as labor, materials, and time to produce goods or services. It reflects the firm's ability to minimize waste, streamline processes, and optimize productivity. Efficient operations lead to cost reduction, faster service delivery, and higher output quality.

Customer Satisfaction

Modupe (2021) defines customer satisfaction as the extent to which customers perceive that the quality of services delivered by an organization fulfills or surpasses their expectations before consumption. The author explains that customer satisfaction is primarily determined by customers' perceptions of service quality dimensions, including reliability, responsiveness, assurance, empathy, and tangible evidence of service quality. According to the study, customers evaluate not only the final product or service outcome but also the professionalism, courtesy, competence, accessibility, and responsiveness of employees during service delivery. Similarly, Aniuga and Ogba (2021) describe customer satisfaction as customers' favourable evaluation of products resulting from the organization's ability to deliver innovative products that effectively satisfy changing customer needs and preferences. The authors maintain that innovation plays a significant role in achieving customer satisfaction because customers continuously seek products that offer superior quality, convenience, value, functionality, and uniqueness. They argue that organizations that invest in product innovation are better positioned to meet customers' evolving expectations, thereby increasing satisfaction levels and strengthening customer loyalty. According to Uwabor et al., (2021), customer satisfaction refers to customers' overall assessment of the quality and effectiveness of electronic services provided by organizations. Ugwunwanyi et al., (2021) define customer satisfaction as customers' overall evaluation of their experiences with an organization's products, services, employees, and corporate reputation.

Small and Medium Enterprises (SMEs)

According to Ezinwa, et al (2020) the concept and definitions of Small and Medium Scale Enterprises (SMEs) was introduced into the development landscape as early as the late 1940s, and the primary aim was to improve trade and industrialization in the present developed nations. The definition of Small and Medium Scale Enterprises (SMEs) varies from country to country, region to region and from agencies to agencies in today's world. The definitions of SMEs are usually derived in each country based on the role of SMEs in the economy, policies and programs designed by particular agencies or institutions empowered to develop SMEs. According to Aremu and Adeyemi (2021), Small and Medium Enterprises (SMEs) are business organizations established with relatively low capital investment, a limited number of employees, and modest annual turnover. The authors explained that these enterprises are usually owned and managed by individuals, families, or small groups of entrepreneurs who utilize available resources to produce goods and services for local and national markets.

Onugu (2025) defined Small and Medium Enterprises as independently owned and managed business establishments that operate on a relatively small scale in terms of capital investment, workforce, production capacity, and annual sales. The author noted that SMEs are characterized by flexible management structures, quick decision-making processes, and close interaction between owners and employees, enabling them to adapt rapidly to changes in market demand. According to Olorunshola (2023), Small and Medium Enterprises are enterprises with relatively small levels of capital investment and employment that contribute substantially to the production and distribution of goods and services within the economy. Sanusi (2023) described Small and Medium Enterprises as business organizations with relatively modest asset bases and workforce sizes that possess the capacity to stimulate industrial growth through innovation, efficient resource utilization, and value addition. According to the author, SMEs occupy a central position in Nigeria's industrialization strategy because they encourage local

production, reduce excessive dependence on imported goods, and facilitate the development of domestic industries.

Theoretical Framework

Resource-Based View (RBV) of the Firm

The resource-based view (RBV) by (Barney, (1991) has become one of the most influential and cited theories in the history of management theorizing. It aspires to explain the internal sources of a firm's sustained competitive advantage (SCA). Its central proposition is that if a firm is to achieve a state of SCA, it must acquire and control valuable, rare, inimitable, and no substitutable (VRIN) resources and capabilities, plus have the organization (O) in place that can absorb and apply them (Barney, 1991a, 1994, 2002). This proposition is shared by several related analyses: core competences (Hamel & Prahalad, 1994), dynamic capabilities (Helfat & Peteraf, 2003; Teece, Pisano, & Shuen, 1997), and the knowledge-based view (Grant, 1996b). Given its elegant simplicity and its immediate face validity, the RBV's core message is appealing, easily grasped, and easily taught. Yet the RBV has also been extensively criticized for many weaknesses. Critiques are valuable for advancing the RBV, for by exploring its limitations they imply where improvements might be made. Along these lines we categorize and assess the eight categories of critiques available so far, adding comments about their severity and impact. Our analysis suggests the RBV's core message can withstand five of these critiques quite well, especially when the RBV's variables, boundaries, and applicability are more clearly specified. However, three threaten the RBV's status as a core theory. These concern the indeterminate nature of two concepts fundamental to the RBV resource and value plus there are problems with the RBV's narrow explanation of a firm's competitive advantage. As we argue, the common theme underlying these critiques is that the RBV has clung to an inappropriately narrow neoclassical economic rationality and has thereby diminished its opportunities for making further progress. Leveraging the critiques and the discussions they have provoked, we suggest directions for future theorizing and research. We argue that the way forward, perhaps, is to move the RBV into an inherently dynamic and subjectivist framework such as Penrose's (1959/1995), (Kraaijenbrink, et al, 2010).

Institutional Theory

Institutional Theory, as articulated by North (1990), posits that institutions are defined as the formal rules (laws, regulations, policies) and informal constraints (norms, conventions, and cultural practices) that structure economic interactions by reducing uncertainty and shaping incentives. Institutions influence how economic actors behave, the costs they incur, and the opportunities available to them. In this framework, organizations such as Small and Medium Enterprises (SMEs) do not operate in isolation; rather, their strategic choices, performance outcomes, and growth trajectories are deeply embedded within the institutional environment in which they function.

In the context of SMEs, institutional arrangements such as customs procedures, trade agreements, taxation systems, property rights enforcement, and regulatory frameworks play a critical role in shaping business behavior and performance. As noted by Sahin and Mert (2023), effective institutions facilitate SME performance by lowering transaction costs, improving access to markets, and providing predictability in economic exchanges. For instance, transparent customs regulations and efficient border procedures reduce delays and costs associated with importing inputs or exporting goods, thereby enhancing competitiveness and operational efficiency. Similarly, well-designed trade agreements can expand market access and create incentives for SMEs to innovate and scale their operations.

Conversely, weak or inefficient institutions can impose significant constraints on SME performance. According to North (1990), poorly enforced rules, regulatory inconsistency, corruption, and bureaucratic inefficiencies increase uncertainty and transaction costs, disproportionately affecting SMEs due to their limited financial and administrative capacities. In environments characterized by weak institutional quality, SMEs may divert resources away from productive activities toward compliance, informal practices, or risk mitigation strategies. This can hinder firm growth, reduce productivity, and limit participation in international trade. Therefore, Institutional Theory provides a robust analytical lens for

understanding how variations in institutional quality explain differences in SME performance across countries or regions, particularly in developing and transition economies where institutional frameworks are often evolving.

Empirical Review

Afolabi and Mudashiru (2026) studied the impact of infrastructure deficiency on logistics and supply chain efficiency in Nigeria using Eddie International Limited, Lagos, as a case study. The study adopted a descriptive survey research design. The population comprised employees of Eddie International Limited involved in logistics and supply chain operations. A sample size of 300 respondents was selected using purposive sampling because of their direct involvement in logistics activities. Data were collected using structured questionnaires and analyzed using descriptive statistics and multiple regression analysis. The findings revealed that poor road infrastructure, inadequate electricity supply, port congestion, and poor communication facilities significantly reduced logistics efficiency by increasing transportation costs, delivery delays, and operational expenses. The study concluded that improved infrastructure is essential for enhancing operational efficiency and competitiveness of firms involved in trade activities. The researchers recommended increased government investment in transport networks, stable electricity supply, modernization of ports, and expansion of ICT infrastructure. The study focused on a single logistics company rather than SMEs engaged in trans-border trade. Future studies should examine how transport, ICT, and energy infrastructure affect the operational efficiency of SMEs involved in cross-border trade across different Nigerian border communities.

Anderson, et al, (2025) studied the effects of COVID-19 border closures on Ghanaian women traders engaged in informal cross-border trade. Findings revealed severe disruptions to livelihoods, including business collapse, increased risks due to reliance on unsafe routes, and further marginalization in regional economies. The study’s focus on gendered impacts provides important nuance often overlooked in trade studies. However, its reliance on qualitative insights without broader empirical validation may restrict the generalizability of its conclusions across West Africa.

Wahab (2024) studied the effect of transport and ICT infrastructure on Nigeria's bilateral trade flows with major trading partners. The study adopted an ex post facto research design using secondary panel data covering 22 major trading partners from 2005–2021. Data were analyzed using an augmented gravity model estimated through econometric regression techniques. The findings showed that improvements in road transport, maritime infrastructure, airport facilities, internet access, and broadband connectivity significantly enhanced Nigeria's trade performance. The study concluded that trade-related infrastructure plays a critical role in facilitating efficient international trade. The researcher recommended greater investment in transportation infrastructure, ICT facilities, and port modernization. The study emphasized bilateral trade at the national level without focusing on SMEs or operational efficiency. Future studies should examine how infrastructure development affects operational efficiency among SMEs participating in trans-border trade in Nigeria.

Aljohani (2023) examined the influence of trade facilitation on SME performance across African countries. The study employed a quantitative panel research design using secondary data obtained from enterprise and trade databases covering several African countries. The study analyzed thousands of SMEs from multiple countries using panel regression analysis. The findings indicated that improvements in transport infrastructure, customs procedures, digital infrastructure, and institutional quality significantly improved SME productivity, export performance, and operational efficiency. The study concluded that investment in trade-related infrastructure reduces transaction costs and enhances competitiveness among SMEs. The authors recommended sustained investments in transport networks, border infrastructure, and digital trade facilitation systems. Although the study covered African SMEs, it did not specifically investigate SMEs engaged in trans-border trade within Nigeria. Future research should focus specifically on Nigerian border SMEs to determine the direct influence of infrastructure on operational efficiency.

Ngalo (2022) examined the influence of government infrastructural facilities, taxation, and security policies on SME performance in Abuja. The study adopted a descriptive survey research design. The

population consisted of registered SMEs operating in the Federal Capital Territory. Using the Krejcie and Morgan formula, a sample size of 336 SME owners was selected through a multistage sampling technique involving cluster, proportionate, and simple random sampling. Data were analyzed using descriptive statistics and multiple regression analysis. The study found that infrastructural facilities significantly improved SME service quality and market growth, whereas taxation showed no significant influence on sales performance. The study concluded that adequate infrastructure is a major determinant of SME operational success. It recommended increased public investment in infrastructure and continuous maintenance of existing facilities. The study focused on SMEs generally without considering firms engaged in trans-border trade or border communities. Future research should investigate the influence of transport infrastructure, border facilities, and ICT on operational efficiency among trans-border SMEs operating along Nigeria's international borders.

Iorember (2022) examined the relationship between trade openness and SME performance in Nigeria. The study adopted an ex post facto research design using annual secondary data covering 1981–2019. Data were analyzed using the Autoregressive Distributed Lag (ARDL) model and the Toda–Yamamoto causality test. The findings showed that trade openness had a positive but statistically insignificant effect on SME performance. However, infrastructure, exchange rate, labour force, and foreign direct investment significantly influenced SME performance. The study concluded that infrastructure remains a critical determinant of SME competitiveness under open trade conditions. The researchers recommended improvements in transport infrastructure, electricity supply, and trade-supporting facilities. The study concentrated on national SME performance and macroeconomic indicators rather than operational efficiency of trans-border SMEs. Future studies should employ primary data from SMEs operating in Nigeria's border regions to examine the direct impact of infrastructure on operational efficiency.

Methodology

The research adopts a descriptive and explanatory survey design. This study was conducted in Adamawa state, Nigeria. The population of this study consists of all registered and unregistered Small and Medium-scale Enterprises (SMEs) engaged in trans-border trade within the border communities of Mubi-North, Mubi-South, Fufore, and Toungo Local Government Areas of Adamawa State, Nigeria. Since the total number of SMEs involved in trans-border trade cannot be accurately established, the study adopted Cochran's (1977) sample size formula designed for an unknown (infinite) population. The formula is expressed as:

$n_0 = Z^2p(1 - p) / e^2$

Where:

n_0 = initial sample size for an unknown population

Z = score corresponding to a 95% confidence level (1.96)

p =estimated proportion of the population possessing the study characteristics (0.5 is used to maximize sample size)

e = margin of error (0.05)

$$n_0 = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2}$$

$$n_0 = \frac{3.8416 \times 2.25}{0.0025}$$

$$n_0 = \frac{0.9604}{0.0025}$$

$$n_0 = 384.16$$

$$n_0 \approx 384$$

Therefore, . To cater for non-response, incomplete questionnaires, and field errors, an additional 10% (38 additional samples) were added, making the total sample size of 422 SMES. Thus, the final sample size for the study is 422 SMEs. This study adopted a stratified purposive random sampling technique.

Table 1: Sample Size based on Strata

S/N	Local Government Area	Senatorial Zone	Border with Cameroon	Estimated SME Trade Concentration (%)	Sample Allocation
1	Mubi North	Northern Zone	Yes	30%	127
2	Mubi South	Northern Zone	Yes	25%	106
3	Toungo	Southern Zone	Yes	20%	84
4	Fufore	Central Zone	Yes	25%	105
Total				100%	422

Source: Researcher's Computation, 2026

The study is based solely on primary sources of data. Primary data are obtained through the administration of structured questionnaires to owners and managers of small and medium-sized enterprises. Primary instrument for data collection in this study is a structured questionnaire. Content validity is ensured by subjecting the questionnaire to critical review by experts in the department of Business Administration and Entrepreneurship assess the extent to which the items adequately represent and cover the variables under investigation.

Data Presentation and Analysis

A total of 422 copies of the questionnaire were distributed to the respondents, representing 100% of the questionnaires administered. Out of this number, 409 questionnaires, representing 96.9%, were returned, while 13 questionnaires, representing 3.1%, were not returned. Furthermore, out of the 409 questionnaires returned, 10 questionnaires, representing 2.4% of the total questionnaires distributed, were rejected due to incomplete responses, improper completion, or other inconsistencies that could affect the reliability of the analysis. Consequently, 399 questionnaires, representing 94.5% of the total questionnaires distributed, were retained and considered valid for data analysis. The response rate of 94.5% is considered sufficiently high and indicates a strong level of participation among the respondents. Therefore, the 399 valid questionnaires provided an adequate basis for the statistical analysis and interpretation of the findings of the study.

Hypotheses Testing

H_o1: Infrastructure has no significant effect on the operational efficiency of SMEs engaged in trans-border trade in selected LGAs of Adamawa State.

Table 1: Model Summary of the effect of infrastructure on operational efficiency

Variables	Coefficients	Std. Error	t-Values	p-values	Hypothesis Testing
(Constant)	41.466	0.570	72.739	0.000	H_o1: Rejected
IT	0.339	0.037	1.108	0.000	
R	0.248				
R^2	0.122				
Adjust. R^2	0.120				
F-Stats	8.942				
a. Predictors: (Constant), IT					
b. Dependent Variable: OE					

Source: Computed using SPSS 27 from Field Survey data, 2026.

Table 1 presents the regression results on the effect of infrastructure (IT) on the operational efficiency (OE) of SMEs. The model summary reveals a correlation coefficient (R) of 0.248, indicating a weak positive relationship between infrastructure and operational efficiency. The coefficient of determination (R^2) of 0.122 indicates that infrastructure explains 12.2% of the variation in operational efficiency, while the remaining 87.8% is explained by other factors not included in the model. The adjusted R^2 of 0.120

indicates that infrastructure accounts for approximately 12.0% of the variation after adjustment. The regression coefficient of 0.339 indicates a positive relationship, implying that a unit increase in infrastructure is associated with a 0.339-unit increase in operational efficiency, holding other factors constant. Based on the reported p-value of 0.000, which is below the 0.05 significance level, the effect is statistically significant. Therefore, the null hypothesis (H_{04}), which states that infrastructure has no significant effect on the operational efficiency of SMEs, is rejected. The study concludes that improved road networks, transportation facilities, border infrastructure, electricity supply, and storage facilities can enhance operational efficiency by reducing delays, lowering operating costs, facilitating the movement of goods, and improving resource utilisation. However, the reported statistics require verification because the t-value of 1.108 appears inconsistent with the coefficient of 0.339, standard error of 0.037, and p-value of 0.000.

H_o2: Infrastructure quality has no significant effect on customer satisfaction among SMEs in selected LGAs of Adamawa State.

Table 2: Model summary of the effect of Infrastructure on customer satisfaction

Variables	Coefficients	Std. Error	t-Values	p-values	Hypothesis Testing
(Constant)	40.124	1.153	34.786	0.000	H_o2: Rejected
IT	0.225	0.089	2.518	0.000	
R	0.325				
R^2	0.116				
Adjust. R^2	0.113				
F-Stats	6.340				
a. Predictors: (Constant), IT					
b. Dependent Variable: CS					

Source: Computed using SPSS 27 from Field Survey data, 2026.

Table 2 presents the regression results on the effect of infrastructure on customer satisfaction (CS) among SMEs. The model summary reveals a correlation coefficient (R) of 0.325, indicating a weak positive relationship between infrastructure quality and customer satisfaction. The coefficient of determination (R^2) of 0.116 indicates that infrastructure quality explains 11.6% of the variation in customer satisfaction, while the remaining 88.4% is attributable to other factors not included in the model. The adjusted R^2 of 0.113 indicates that infrastructure quality accounts for approximately 11.3% of the variation after adjustment. The regression coefficient of 0.225 indicates that a one-unit increase in infrastructure quality is associated with a 0.225-unit increase in customer satisfaction, holding other factors constant. The t-value of 2.518 and reported p-value of 0.000 indicate that the relationship is statistically significant at the 5% level. Therefore, the null hypothesis (H_{05}), which states that infrastructure quality has no significant effect on customer satisfaction among SMEs, is rejected. The study concludes that improved road networks, transportation systems, storage facilities, border facilities, and other supporting infrastructure can facilitate timely product delivery, improve product availability, enhance service delivery, and ultimately strengthen customer satisfaction and retention among SMEs engaged in trans-border trade.

Summary of Findings

The following findings were derived from the above analysis:

1. Infrastructure had a positive and statistically significant effect on the operational efficiency of SMEs, with β = 0.339 and p = 0.000. This suggests that improvements in road networks, transportation facilities, border infrastructure, and storage facilities enhance the movement of goods and the efficiency of SME operations.
2. Infrastructure had a positive and statistically significant effect on customer satisfaction, with β = 0.225, t = 2.518, and p = 0.000. This implies that adequate infrastructure facilitates product availability, timely delivery, and effective service delivery, thereby enhancing customer satisfaction.

Discussion of Findings

The finding revealed that infrastructure has a positive and statistically significant effect on the operational efficiency of SMEs. The positive coefficient of 0.339 indicates that improvements in roads, transportation facilities, border infrastructure, and storage facilities contribute to the efficient operation of SMEs. This finding is consistent with the study on small-scale enterprises in Zamfara State, which examined transportation, electricity, and technological infrastructure as important factors influencing enterprise performance. The result is also supported by Azu (2020), who observed that inadequate basic infrastructure contributes to high production costs and, in extreme situations, the loss of goods. Consequently, adequate infrastructure enables SMEs to move goods more efficiently, reduce operational disruptions, and improve the utilisation of business resources.

The finding indicated that infrastructure quality has a positive and statistically significant effect on customer satisfaction among SMEs. The coefficient of 0.225 suggests that improvements in infrastructural quality contribute to higher customer satisfaction. Good roads, efficient transportation systems, adequate storage facilities, and reliable border facilities can facilitate timely product delivery and improve product availability. This finding is in line with Akinyele et al.'s study of infrastructure and SME performance, which highlighted the importance of infrastructure to enterprise performance. It also supports Gazi et al. (2022), who emphasised the importance of customer satisfaction to SME business performance in Nigeria. The implication is that infrastructure creates the operational conditions required for SMEs to deliver goods and services in a manner that meets customer expectations.

Conclusion

In conclusion, the study established that infrastructure has a positive and statistically significant effect on both the operational efficiency and customer satisfaction of SMEs engaged in trans-border trade in selected local government areas of Adamawa State. Improved road networks, transportation facilities, border infrastructure, and storage facilities enhance the movement of goods, reduce operational delays, and promote efficient resource utilisation. Similarly, adequate infrastructure facilitates timely product delivery, improves product availability, and enhances service quality, thereby increasing customer satisfaction and strengthening customer retention. The study therefore concludes that infrastructural development is essential for improving SME performance, promoting competitiveness, and supporting the sustainable growth of trans-border trade in Adamawa State.

Recommendations

The following findings were derived from the above findings and conclusion:

Federal, state, and local governments should invest in the development and rehabilitation of road networks, transportation facilities, border infrastructure, and storage facilities in trans-border trading areas to reduce operational delays and improve the efficiency of SME business activities.
Relevant government authorities should improve the quality and reliability of infrastructure supporting SME operations to facilitate timely product delivery and availability.

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