ENHANCING AI COMPETITIVENESS AND TECHNOLOGICAL INNOVATION FOR GROWTH-ORIENTED SMALL BUSINESSES IN SUB-SAHARAN AFRICA

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A R T I C L E   I N F O

A B S T R A C T

Small businesses in sub-Saharan Africa (SSA) face unique challenges, including limited access to finance, inadequate infrastructure, and a lack of technical expertise, all of which hinder their ability to adopt and integrate advanced technologies such as artificial intelligence (AI). Despite these challenges, technological innovation—particularly AI—holds considerable potential for enhancing the AI competitiveness and growth of small enterprises in the region. Nigeria is a key market in Africa and one of the largest economies on the continent. Moreover, small businesses are major contributors to Nigeria's economy, but they encounter many challenges, including AI competitiveness. In recent years, researchers and business experts have sought effective ways to explore the relationship between technological innovation capabilities and AI competitiveness in various contexts. Therefore, this chapter aims to examine the impact of technological innovation capabilities on the AI competitiveness of pro-growth listed small businesses in Nigeria. A closed-ended questionnaire was designed and distributed, with 421 responses received, translating to a response rate of ninety-five per cent (95%). The results of the simple linear regression analysis indicated that technological innovation capabilities have a positive and significant effect on the AI competitiveness of small, pro-growth listed businesses in Nigeria ($B = 0.442$, $t = 7.589$, $p < 0.05$). This suggests that technology adoption and innovation are strong predictors of AI competitiveness among small businesses in Nigeria. The chapter recommends that small businesses cultivate an organisational culture that fosters creativity, experimentation, and lifelong learning. They should ensure that senior management actively supports and contributes to technological innovation initiatives and innovative ideas, as well as allocate resources to enhance AI competitiveness.

INTRODUCTION

Innovation is currently important for small business competitiveness and profitability. Africa's small business development has witnessed significant growth in recent years, yet AI competitiveness remains a key challenge for the region. Technological innovation is viewed as a critical facilitator of business growth and competitive advantage in the quickly changing global economy of today (Mendoza-Silva, 2021). The business environment is more competitive and complex, with several firms prioritising profit (Ninduwezuor-Ehiobu et al., 2023). In Nigeria, both large firms and small to medium enterprises encounter significant competition (Mohammed, 2023). To be competitive, companies must remain informed about market trends, consumer preferences, and business advancements. The competitive environment has changed dramatically as technology continues to transform businesses. Integrating cutting-edge technologies, especially artificial intelligence (AI), is becoming more and more crucial for survival and expansion for both small and large international enterprises. It has been demonstrated that implementing AI and other technical advancements can boost consumer engagement, increase operational efficiency, and influence strategic decision-making (Adama, Popoola, Okeke, & Akinoso, 2024; Brynjolfsson & McAfee, 2017). Adoption of technology can be revolutionary for small businesses, especially in emerging economies, providing a way to scale more effectively and compete with larger companies (Awode & Oduola, 2025).

AI-driven solutions can enhance sustainability in the industrial sector by optimising production processes, reducing waste, and adhering to the SDG 9 indicators (Blichfeldt & Faullant, 2021; Chen & Lee, 2020). AI has the power to aid in economic growth, job creation, and environmental sustainability. Artificial intelligence may aid small and

medium-sized firms (SMEs) in implementing sustainable practices by optimising resource utilisation, reducing waste, and improving supply chain efficiency. This constitutes a facet of the overarching sustainability strategy. Teece's 2018 research illustrates the use of AI in overseeing and mitigating the environmental repercussions of corporate operations. This improves corporate sustainability and coincides with Sustainable Development Goal 12 (Responsible Consumption and Production). The integration of AI and other new technologies improves the competitiveness of small and medium-sized firms, while also aiding their contributions to developmental goals, particularly the achievement of the Sustainable Development Goals (SDGs). Despite the potential advantages of these technologies for small firms in Sub-Saharan Africa, their adoption is impeded by considerable constraints, such as high initial costs, a lack of experienced workers, and insufficient infrastructure. These obstacles impede small and medium-sized firms (SMEs) from efficiently using AI for growth and innovation.

Globally, enterprises seeking to maintain relevance in the digital era must integrate AI into their operations to secure a competitive advantage. The World Economic Forum (WEF) projected in 2020 that AI may contribute up to $15.7 trillion to global GDP by 2030, driving innovations, consumption, and productivity enhancements across many sectors. Artificial intelligence is being embraced in wealthy economies such as the United States, China, and European Union states, although its integration in developing ones remains nascent. Small enterprises in Sub-Saharan Africa (SSA) have significant challenges in accessing and using technological improvements due to factors such as insufficient infrastructure, high costs, and a shortage of trained labour. The fastest-growing region in the globe is Sub-Saharan Africa, but it also has particular difficulties that restrict its economic potential (Tetteh, 2024; Ali & Anwar, 2021). AI adoption is still comparatively low in the region, despite significant advancements in technology adoption, such as the sharp rise in internet and mobile phone use. According to the African Development Bank, hardly 1% of African companies have integrated AI into their daily operations. Nevertheless, AI has enormous potential to propel economic growth across the continent, especially in the small business sector. In SSA, small firms which make up around 90% of all businesses and, in some countries, up to 60% of the labour force are essential for economic diversification, job creation, and poverty reduction (YuSheng & Ibrahim, 2020). Prior research in Nigeria revealed that several Nigerian organisations have challenges in competing in international marketplaces owing to insufficient innovation in their products (Edeh, Obodoechi, & Ramos-Hidalgo, 2020). Organisations that use external information to enhance their systems are more inclined to innovate and achieve a competitive edge. To maintain market AI competitiveness, businesses must provide superior goods in response to rapid technological progress. Prior research suggests that an organization's AI competitiveness is influenced not just by innovation but also by the velocity of its innovative processes. This rate is essential for success. To enhance innovation, firms have to collaborate with other organisations to address shortcomings and capitalise on mutual strengths to develop products and achieve a competitive advantage (Koentjoro & Gunawan, 2020). To develop according to client demands, businesses must first ascertain these needs. Assessing small business AI competitiveness is essential for the development of the sector (Tetteh, 2024; Rumanti et al., 2022). Previous research in this area was predominantly limited to traditional strategic analysis frameworks or primarily concentrated on financial metrics. This paper's goal is to fill the gap by giving background information on how technological innovation affects AI competitiveness and looking at the relationship in a small number of small businesses in Nigeria, which has the most people and is one of the largest economies in Africa.

Small businesses add a lot to the GDP and employment of Nigeria, one of the biggest economies in Sub-Saharan Africa. However, these enterprises face several challenges, including limited financial resources, insufficient infrastructure, and a lack of technological knowledge. Small enterprises in Nigeria might gain enhanced market access, improved decision-making, and increased operational efficiency through the integration of AI and technological improvements. AI-driven solutions may aid small enterprises in enhancing marketing strategies, optimising supply chains, and augmenting customer interaction through customisation (Vaia, Arkhipova, & DeLone, 2022; Afolabi, 2021). Despite these potential benefits, Nigerian small enterprises remain well behind in the adoption of AI and other technological breakthroughs. The specific relationship between technological innovation and AI competitiveness for pro-growth small companies in Sub-Saharan Africa, particularly in Nigeria, constitutes a study gap. Despite several studies highlighting the potential of technology and AI in major organisations and economies (Binns, 2019), there is a scarcity of comprehensive research investigating the prospects and challenges of AI adoption among small enterprises in Sub-Saharan Africa. Furthermore, there is little practical data on how AI might improve small enterprises' competitiveness in SSA, where adoption of technology is hampered by issues including infrastructure, cost, and a lack of skilled workers (Dhliwayo & Chebo, 2024; Vahdat, 2022). By concentrating on the interaction between technological innovation and artificial intelligence (AI) in small firms, this study will close this gap and offer insights into how AI may be used to boost growth, improve competitiveness, and get over obstacles in SSA.

The current economic circumstances in Nigeria and other Sub-Saharan African nations underscore the importance of this study. The COVID-19 pandemic has accelerated businesses' digital transformation, highlighting the importance of technological resilience in managing future crises. The COVID-19 epidemic has demonstrated the necessity for small enterprises in SSA to adopt digital solutions to remain sustainable and competitive. Nonetheless, the slow adoption of AI and technology by small enterprises continues to hinder their ability to compete effectively in an increasingly digitised global economy. In order to close the research gap and promote long-term economic growth and competitiveness, this study intends to offer practical suggestions for small firms in Nigeria and SSA to enhance their technological innovation strategies and AI adoption. This article examines the relationship between technological innovation and AI competitiveness of small businesses, illustrating how novel procedures may streamline operations and enhance efficiency (Tariq, Poulin, & Abonamah, 2021). Therefore, the objective of this study is to investigate the effect of technological innovation dimensions

on the AI competitiveness of selected pro-growth listed consumer goods companies in Nigeria. So overall the article examines the impact of technological innovation on AI competitiveness among small businesses in sub-Saharan Africa, with a focus on Nigeria. It highlights the challenges these businesses face, such as limited access to finance, poor infrastructure, and lack of technical expertise, which hinder their adoption of advanced technologies like AI. Despite these obstacles, AI holds significant potential for enhancing business growth. Using data from a closed-ended questionnaire with 421 responses, the study finds that technological innovation capabilities positively and significantly influence AI competitiveness. The article recommends fostering a culture of creativity and experimentation, ensuring active senior management support for innovation, and allocating resources to boost AI competitiveness. Ultimately, it underscores the need for small businesses in Nigeria to prioritize technology adoption to remain competitive in an increasingly digital world.

LITERATURE REVIEW

Small Business
The growth of small businesses in Nigeria goes back to before colonisation, therefore it is a natural element of the country. There is a lot of proof in our communities about what our great-grandparents did to help small businesses develop. Our communities and parents have always done quite well in trading, iron-smelting, farming, cottage industries, and other things like that. Also, the country's small businesses were given priority via a series of government programs, which were seen as the source of strength for the economy's recovery. Gyang and Badung (2019) say that the problems of small businesses have been seen as those of the whole country because there are so many of them, they are so different, and they are involved in all areas of production and making big contributions to employment and the prosperity of the areas where they work. Small businesses are often started by a small group of owners or even just one owner, and they don't usually have any established procedures or operations. Owners of small businesses often don't have the skills or knowledge to run them well, which makes the growth stage very important. To be successful, they need to have a clear vision and mission. Also, small businesses in Nigeria hire people, which lowers the amount of poverty in the economy and improves the quality of life for the people who live there. To keep the economy strong, small businesses need to be less likely to fail. Small businesses are very important for creating a landscape of opportunity where people can turn ideas into businesses and goals into achievements. Small businesses play, focussing on their ability to encourage innovation, promote entrepreneurship, and revitalise local economies. However, it's tremendous potential is still hampered by a number of problems, such as limited access to money, regulatory issues, and lack of knowledge (Tetteh, 2024).

Innovation
Innovation is the cornerstone of the arsenal of modern organizations and shapes their competitiveness, growth, and sustainability in a dynamic market. Several authors have outlined innovation in various ways and emphasized its role as a catalyst for business progress and change. Innovation is essentially the creation or introduction of new ideas, processes, products or services to create value and respond to changing market demands. Innovation refers to novel technologies, methods, and systems that advance society and improve people's lives (Wanof, 2023). Furthermore, innovation for governments should include more than just specific innovations or processes. Manufacturing should be viewed as a process that absorbs new ideas into the economy, alters the product, and organises production methods (St-Pierre, Julien, & Fadil, 2023). Innovation is a key measure of economic success, driving development and generating new commercial opportunities. Innovation helps compete with high-quality, low-wage economies while maintaining high-wage standards.

Technological Innovation
Technological innovation significantly contributes to contemporary business and economic growth. It is widely recognised for its capacity to transform several domains. Technological innovation entails the creation of new technologies or the enhancement of existing ones. Companies utilise this strategy to surpass competitors, enhance efficiency, and expand their consumer base (Ferreira, Cardim, & Coelho, 2021; Osman, Liu, & Wang, 2023). Technological innovation includes the development of novel products, services, processes, and business models. Small enterprises must adopt new technology to remain operational and prosper, particularly in developing regions such as Sub-Saharan Africa (SSA), where the digital gap remains a significant issue. A company's technological innovation capability depends on its internal resources (human, technological, and organisational) and its ability to integrate external resources, knowledge, and skills to create new products and processes that stakeholders value (González-Ramos, Guadamillas, & Donate, 2023).

AI Competitiveness
Artificial intelligence (AI) has emerged as a fundamental element of contemporary business operations, fostering innovation, efficiency, and competitive superiority across all sectors. AI competitiveness refers to a firm's capacity to leverage artificial intelligence technologies to sustain or enhance its competitive standing in the market (Binns, 2019). The strategic implementation of AI technologies enables companies to augment operational efficiency, develop product offerings, and enhance consumer experiences, hence increasing market success. The concept of AI competitiveness refers to a firm's ability to leverage AI technology to outpace competitors in efficiency, customer experience, product offers, and market share (Davenport, Guha, & Grewal, 2020; Binns, 2019). The competitiveness of AI is a vital factor in the success of modern businesses. The integration of AI technology enables firms to enhance efficiency, improve user experiences, foster innovation, and support data-driven decision-making. Artificial intelligence has considerable potential to improve competitiveness and growth for small businesses, especially in Sub-Saharan Africa (Tetteh, 2024). However, barriers such

as limited access to AI technology, high implementation costs, and a lack of skilled workers hinder AI adoption in these domains. As businesses in Sub-Saharan Africa address these challenges, understanding the benefits and applications of AI is essential for developing policies and strategies that improve AI competitiveness in emerging economies.

Theoretical Review
Innovation Diffusion Theory
Everett Rogers' innovation diffusion theory offers a framework for comprehending the mechanisms, motivations, and velocity of the dissemination of innovative ideas and technology across cultures. This theory is crucial for a firm's competitiveness as it elucidates the acceptance of innovations and the factors influencing their spread inside and among organisations (Kiveu, Namusonge, & Muathe, 2019). Innovation diffusion theory posits that the adoption of innovative ideas transpires in a predictable manner. Innovations are introduced, and their adoption disseminates among several demographic categories, including innovators, early adopters, early majority, late majority, and laggards (Guttentag & Smith, 2022). Each category signifies a distinct level of preparedness and capability to embrace new technologies or methodologies.

Component
The diffusion of innovations involves a complex interplay of several elements that collectively determine how and when an innovation is adopted within a population. These elements include innovation, communication channels, time, and the social system. Innovation: Innovation is fundamental to the dissemination process. It refers to a concept, activity, or thing that is seen as novel by a person or another unit of adoption (Clohessy, Acton, & Rogers, 2019). The perceived features of an innovation have a substantial effect on its rate of adoption. The degree to which an invention is seen as superior to the concept it replaces. Innovations with obvious benefits are more likely to be accepted rapidly. The degree to which an invention is seen as difficult to comprehend and use. Simpler inventions are typically embraced sooner. The extent to which an idea can be tried out on a modest scale (Yang, Zhou, Wang, Lin, & Luo, 2019). Innovations that can be evaluated and tried without complete commitment are more likely to be embraced quickly. Communication Channels: Communication channels are the mechanism by which knowledge about an innovation is distributed from one person to another (Muller & Peres, 2019).

The dissemination process is strongly dependent on both mass media and interpersonal channels. Television, radio, newspapers, and online channels may all reach a big number of people rapidly. They are effective in raising awareness about the innovation. These may also include face-to-face contacts between persons. They are critical for influencing others to accept an invention since they allow for more in-depth discussions and personal endorsements (Crupi, Del Sarto, Di Minin, Phaal, & Piccaluga, 2021). Time: This refers to the steps that an individual or organisation takes to embrace or reject an invention after first learning about it. Knowledge, persuasion, decision-making, execution, and confirmation are typical steps in the process. Individuals in a social system can be classed according to their innovativeness. The five groups are innovators, early adopters, early majority, late majority, and laggards. Each organisation implements an invention at a different time and for various reasons. This is the rate at which an invention is accepted by members of a social system. The perceived features of the invention, the sort of social structure, communication methods employed, and the form of promotion activities all have an impact on adoption rates (Melović, Jocović, Dabić, Vulić, & Dudic, 2020). Social System: The social system refers to the network of persons, organisations, or institutions that may accept the invention (DiMaggio, 2019). The social system provides the context for dispersion. Cultural norms and values within a social system have a considerable influence on the dissemination process. Innovations that adhere to these rules are more likely to be adopted. The structure of social interactions inside the system, such as hierarchies, networks, and communication patterns, influences how knowledge about the invention is shared and implemented (Dahesh, Tabarsa, Zandieh, & Hamidizadeh, 2020).

Strengths of the Theory
Innovation diffusion theory offers a structured framework for businesses to comprehend the process of innovation adoption. Companies may effectively target various adopter categories by classifying them as innovators, early adopters, early majority, late majority, and laggards (Dutta & Sarma, 2020).

Empirical Review
The empirical literature supports the notion that AI and emerging technologies are crucial for enhancing company competitiveness. Business competitiveness has historically relied on technological innovation. SMEs are increasingly adopting technology to address obstacles and gain a competitive edge. Research shows that technological innovation boosts business competitiveness by boosting productivity, lowering costs, and improving consumer experiences. Automation and AI increased SMEs' productivity in emerging economies, notably SSA. Business output increased by automating routine processes and reducing physical labour. Small enterprises in SSA have little capital and labour, which limits productivity. Teece (2018) studied how digital technologies enable business process innovation. Technology adoption helps small businesses, especially in SSA, improve processes and offer products and services faster. Digitising business models boosted speed to market and eliminated operational inefficiencies, making SMEs more competitive in saturated markets (Teece, 2018). The empirical research reviewed demonstrate that technological innovation, particularly AI, drives company

competitiveness across industries. However, combining technical innovation and AI allows organisations to outperform competitors in efficiency, consumer engagement, and innovation. Technological innovation prepares firms to incorporate AI and other digital tools, whereas AI accelerates innovation, enables data-driven decision-making, and boosts competitiveness (Brynjolfsson & McAfee, 2017). Additionally, integrating AI into technical innovation helps firms improve operational efficiency, cut costs, and distinguish products and services. This combination of technical innovation and AI can help SSA SMEs overcome market access, resource, and skills shortages. The empirical evidence shows that integrating AI with existing technical advancements will assist SSA SMEs survive and grow in a competitive global market. This discussion leads to generating a hypothesis. Consequently, this study sought to bridge the gap in prior and related studies and hypothesized thus:

H_{o1}: *There is no significant effect of technological innovation capabilities on the AI competitiveness of pro-growth listed small businesses in Nigeria.*
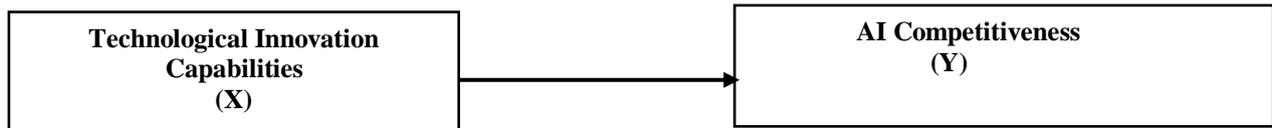
Conceptual Model

Technological Innovation Capabilities (X)	→	AI Competitiveness (Y)

Figure 1. Author's Conceptual Model (2025)

MATERIALS AND METHODS

The small business sector is the focus of this study, and only companies' pro-growth listed on the Nigerian Exchange Group are included in the current examination. This quantitative analysis looked at small businesses that were listed on the Nigerian Exchange Group as of July 2024. The Nigerian Stock Exchange has nine (9) small and medium-sized businesses (SMEs) pro-growth listed under the Alternative Securities Market (ASeM). This study chose five (5) of the nine (9) Small and Medium Enterprises (SMEs) on the alternative security market based on their market capitalisation. The companies are RAK Unity Petroleum PLC, Smart Products Nigeria PLC, Chellarams, Capital Oil PLC, and McNichols PLC. These companies make up 55.56% of the overall capitalisation. The study used a cross-sectional survey research strategy. The survey was chosen because it is a good way to find out what different groups of people think, feel, and believe about the subject of the study and to get more honest and valid input.

RESULTS

The research worked with 421 out of 443 copies of the questionnaire, which is a response rate of 95%. The response rate is the number of people who filled out the survey and got copies of the questions. The others were either not sent back or had answers that were missing. However, the total number of questionnaires collected was adequate to represent Nigeria's small businesses, and they were looked at. The answers are shown in detail in Table 2.

Table 2. Response Rate

	Total	Percentage %
Valid and usable questionnaire	443	95
Invalid/Incomplete questionnaire	22	5
Total received	421	100

Source: Researchers' computation (2025)

We used the structural equation model statistical tool to test the hypothesis. We got data on the technological innovation capabilities and AI competitiveness of pro-growth listed small businesses in Nigeria by combining the answers to all the questions for each variable to make indicators for each. Tables 3 and 4 show the outcomes of the analysis. We employed Smart Partia1, Least Square analysis to see if the research model that shows the link between technological innovation capabilities and AI competitiveness of pro-growth listed small enterprises in Nigeria could make accurate predictions. The study's hypothesis test shows how the technical innovation capabilities and AI competitiveness of pro-growth listed small enterprises in Nigeria affect each other. The study used the path coefficients, t-statistics, R-square, and p-values to figure out the level of impact and the strength of the link between the technological innovation capabilities and AI competitiveness of pro-growth listed small businesses in Nigeria. Figure 2 shows the route coefficient value, which shows how closely technical innovation capabilities and AI competitiveness are related for pro-growth listed small enterprises. We also used the R-squared values in Figure 2 to find a difference in how competitive AI is among pro-growth listed small enterprises, which is explained by their ability to innovate technologically. Figure 3 shows the p-value, which tells us how statistically significant the tested hypothesis is. The t-statistic also helps to explain the differences that were estimated in terms of standard error, which is shown in Figure 4.
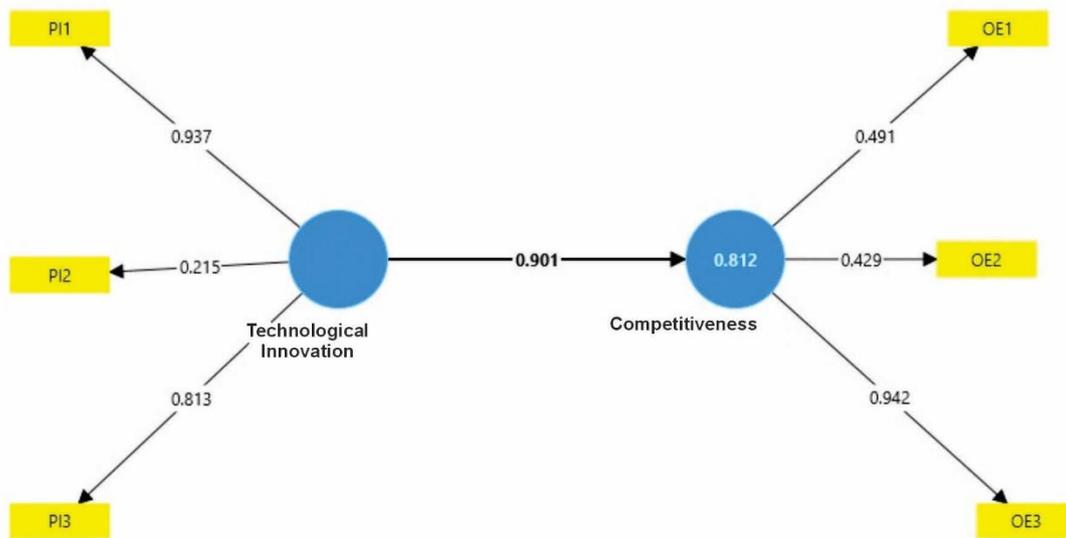
Figure 2 displays the PLS algorithm model for the technological innovation and AI competitiveness of pro-growth small enterprises that are listed. The path coefficient value of 0.901 for the technical innovation capabilities and AI competitiveness of pro-growth listed small enterprises indicates how strong the link is between the independent and dependent variables. The R square (R^2) value is 0.812, which falls into the categories of strong (>0.75), moderate (>0.50), and weak (<0.25). This means that technical innovation capabilities can explain 81.2% of the differences in AI competitiveness among pro-growth listed small enterprises. Because of this, the ability to innovate with technology has a moderate effect on how competitive AI is in pro-growth small enterprises.
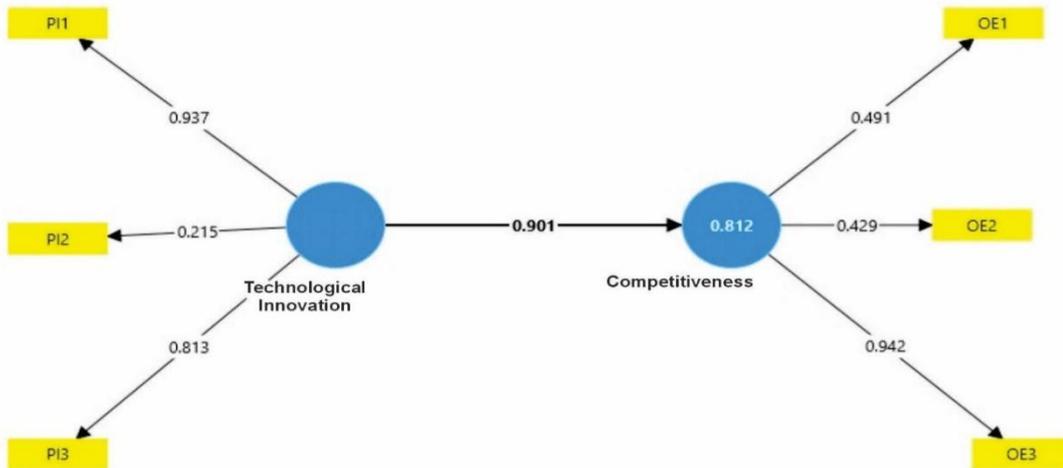

Figure 3. PLS Bootstrapping Model with β and P values of technological innovation capabilities and AI competitiveness of pro-growth listed small businesses.

We utilised the standard coefficient to see how important the hypothesis was. It shows how much the dependent variable is likely to change when the independent variable changes by one unit. It's important to remember that pro-growth listed small enterprises have a bigger effect on AI competitiveness when technical innovation capabilities are stronger. The T-statistical test showed that the ability to innovate technologically has a big effect on how competitive AI is for pro-growth small enterprises that are listed.
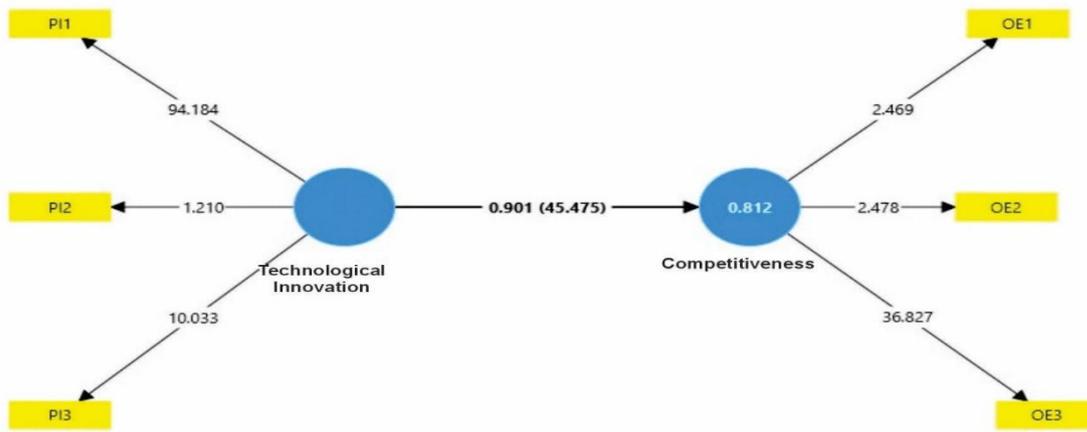
Figure 4. T-statistics showing the standard error of technological innovation capabilities and AI competitiveness of pro-growth listed small businesses

Table 3. Confirmatory Factor Analysis for Hypothesis

Constructs	Loading	AVE	Composite Reliability	Cronbach's Alpha	RhO.A
	> 0.7	>0.5	> 0.8	> 0.7	
Technological innovation capabilities		**0.528**	**0.732**	**0.489**	**0.829**
PI1	0.937				
PI2	0.215				
PI3	0.813				
AI competitiveness of pro-growth listed small businesses		**0.437**	**0.672**	**0.497**	**0.853**
OE1	0.491				
OE2	0.429				
OE3	0.942				

Source: Researchers' computation (2025)

Table 3 shows the factor loadings for all the parts of the measurement of technological innovation skills on the AI competitiveness of small pro-growth enterprises, as reported by the study instrument. The validity and reliability of the research tool were further checked using composite reliability, average variance extracted (AVE) estimation, and Cronbach's Alpha. The suggested statistical values for the AVE, Cronbach's Alpha, composite reliability, and factor loading were all met. This study also used convergent and discriminant validity to figure out construct validity. Convergent validity shows how technological progress affects the AI competitiveness of small enterprises that are pro-growth and listed. It should also be made clear that all of the factor loadings for each measurement item are over the required levels. This means that a lot of the variance is shared by all of the things. While checking for discriminant validity, AVE was set equal to the squared correlation for each construct at the same time. The AVE of the latent variable is higher than the squared correlations in the model between the dormant variable and the constructs.

Table 4. Path Coefficient for Hypothesis

Variables	T Statistics	P Values	Path Co-efficient	R^2
Structural Path				
Technological innovation capabilities → AI competitiveness of pro-growth listed small businesses	**45.475**	**0.000**	**0.901**	**0.812**
PI1	94.184	0.000		
PI2	1.210	0.226		
PI3	10.033	0.000		
OE1	2.469	0.014		
OE2	2.478	0.013		
OE3	36.827	0.000		

Source: Researchers' computation (2025)

Table 4 depicts the smart partial least squared statistical results of the hypothesis, which focused on the relationship between technological innovation capabilities and AI competitiveness of pro-growth listed small businesses. The findings show that technological innovation capabilities affect the AI competitiveness of pro-growth listed small businesses. Specifically, the results showed that the rule of technological innovation capabilities on AI competitiveness of pro-growth listed small businesses, at (β= 0.916, t-statistics= 57.767 > 1.96, P-value= 0.000 <0.05). The Path coefficient of 0.916 implies a strong and positive correlation between technological innovation capabilities and the AI competitiveness of pro-growth listed small businesses.

DISCUSSIONS

The findings of this study strongly support the original hypothesis that technological innovation capabilities positively influence the AI competitiveness of pro-growth listed small businesses. The primary hypothesis, which posited that technological innovation would significantly enhance AI competitiveness, was confirmed through regression analysis, yielding a significant result (T= 2.515 P= 0.001[b]). This supports the notion that businesses with greater technological innovation capabilities are more likely to leverage AI to improve their competitive standing. The study's findings confirm that technological innovation capabilities significantly enhance the AI competitiveness of pro-growth listed small businesses. Regression analysis revealed a significant relationship, underscoring the importance of innovation in driving AI performance. This outcome is consistent with previous research, such as Manyika et al. (2017), which demonstrated that firms adopting radical technological innovations significantly boosted their AI competitiveness. The results suggest that substantial modifications or entirely new methods of production and distribution play a crucial role in improving efficiency, quality, and savings. Additionally, the competitive and regulatory contexts shape how technological innovation impacts AI competitiveness. In highly competitive markets, businesses must continually innovate to maintain or enhance their position, which showed that firms investing in innovation outperformed competitors in both cost-effectiveness and efficiency. However, in regulated sectors, innovation may be constrained, though compliance-driven improvements still contribute to efficiency gains. The role of lean management principles, also emerged as a key factor in enhancing AI competitiveness. Moreover, the study found that firms with higher research and development investment had better financial performance, who emphasized that product innovation drives sales growth and market share. Finally, the use of digital technologies like automation, AI, and IoT further enhances AI competitiveness, aligning with Manyika et al. (2017), who noted that digitalization boosts operational efficiency and responsiveness to market changes. The study's results suggest that small businesses should prioritize technological innovation, not only for improving AI competitiveness but also for driving long-term growth and profitability. Future research should explore the specific technological innovations that contribute most to AI competitiveness in various sectors and examine how businesses can overcome barriers to innovation in regulated industries. The results of this study validate the hypothesis that technological innovation capabilities have a significant impact on the AI competitiveness of pro-growth listed small businesses.

From a theoretical perspective, the findings reinforce the concept that technological innovation serves as a driver of business competitiveness, especially in industries where market dynamics and technological advances evolve rapidly. The positive relationship between technological innovation and AI competitiveness supports the notion that businesses with higher innovation capabilities are better positioned to leverage AI for performance improvements. The results suggest that firms are not only adopting new technologies but are strategically utilizing them to gain a competitive edge, validate their market positions, and enhance their overall efficiency.

Practically, the study's results have significant implications for small businesses in Nigeria and the broader sub-Saharan African context. Small enterprises in highly competitive sectors must prioritize technological innovation as a means to remain relevant and competitive in the global marketplace. Furthermore, the finding that research and development investment correlates with superior financial performance underscores the importance of allocating resources to innovation, as this can translate into improved profitability and market share. For businesses operating in regulated environments, the results suggest that while innovation may be constrained, there is still room for efficiency improvements through compliance-driven technology upgrades. The practical implication for small businesses is clear: adopting technological innovation, including AI, should be a strategic priority. The study suggests that fostering a culture of innovation and ensuring leadership support for innovation initiatives are critical steps in improving AI competitiveness. Small businesses should also focus on enhancing their technical capabilities by investing in R&D and digital technologies to stay ahead of their competitors.

In conclusion, the study highlights that small businesses in Nigeria can enhance their AI competitiveness by focusing on technological innovation. This finding adds weight to the argument that innovation is a key driver of business success in an increasingly digital world. Future research could explore the specific types of technological innovations that contribute most to AI competitiveness in various business sectors, further refining strategies for small businesses to adopt and integrate advanced technologies. Additionally, exploring the barriers small businesses face in implementing these technologies especially in regulated sectors would provide valuable insights into how to overcome these challenges.

CONCLUSIONS

The study shows that technical innovation capabilities significantly influence the competitive viability of pro-growth listed small firms. Significant findings indicate that enterprises investing in technology-driven innovations such as digital marketing, process automation, data analytics, and product creation see enhancements in customer satisfaction, market responsiveness, and operational efficiency. Furthermore, technological innovation enhances scalability, distinctiveness, and cost efficiency, enabling small businesses to effectively compete with bigger firms. The study identifies obstacles hindering the complete utilisation of technological capabilities, including insufficient funding, a deficit of skilled labour, and resistance to change; surmounting these challenges is crucial for sustaining innovation and long-term competitive advantage. The report advises organisations to invest strategically in

advanced technologies such as automation, big data analytics, cloud computing, and artificial intelligence. These expenditures will ultimately fortify their competitive position by improving operational efficiency, cost management, and market agility. Furthermore, to motivate small firms to adopt new technology, authorities may offer incentives such as grants, tax reductions, and low-interest loans. To protect sensitive data and maintain stakeholder and customer confidence, firms must concurrently enhance their cybersecurity measures by implementing robust security frameworks. Companies must prioritise capacity building by providing continuous training programs that provide employees with essential technical knowledge and digital competencies. Collaboration between academic institutions, research centres, and industry personnel may foster innovation and facilitate information exchange.

A main limitation of this study is its dependence on self-reported data, which may be influenced by biases such as social desirability bias, wherein respondents tend to give answers they perceive as more socially acceptable or anticipated rather than accurate. This study recognises many limitations, with the most significant being the exclusion of critical variables, such as infrastructure, which undeniably impacts the competitiveness of small businesses in AI. Nonetheless, it is posited that several of them may function as significant precursors for forthcoming study endeavours. This study's focus solely on small businesses in Nigeria, restricts the generalizability of its conclusions. The findings and consequences of this research are acknowledged to be specific to Nigeria, with a primary emphasis on small firms, perhaps constraining the generalizability of the results. Consequently, the cross-sectional design of the study limits the author's ability to assert definitive causal relationships. The research could be augmented by analogous studies performed across several industries and more publicly traded companies in Nigeria or other nations to facilitate international comparison assessments. Moreover, subsequent research may employ alternative data collection and processing techniques to enhance statistical significance.

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