

Technological Capabilities and Competitive Advantage: The Mediating Role of Operational Efficiency of Manufacturing SMES

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Abstract

This study examines the influence of technological capabilities on the competitive advantage of manufacturing SMEs in Lagos State, Nigeria, and the mediating role of operational efficiency. The study combines four components of technological capabilities and explains operational efficiency as a mechanism linking them to competitive advantage. A cross-sectional mixed-methods design was adopted. The study analysed quantitative data from 298 respondents across three manufacturing sectors using SPSS 26, regression, and Hayes PROCESS Model 4, followed by semi-structured interviews and thematic analysis. ICT infrastructure, digital marketing, process automation and innovation capabilities each had significant positive effects on competitive advantage. Jointly, the four capabilities explained 20.6% of its variance. Operational efficiency produced a significant indirect effect of 0.1419 (95% CI [0.0371, 0.2596]), indicating partial mediation. Interview evidence showed that technology creates competitive value mainly when it improves communication, customer reach, process speed, coordination, innovation and resource utilisation. Manufacturing SMEs should integrate technological investments with operational improvement and workforce capability development.

Keywords: *Technological capability, competitive advantage, innovation capability, SMEs*

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I. Introduction

Small and medium scale manufacturing enterprises (SMEs) play a tremendous role in the economic development of Nigeria. Lagos State is an industrialized zone which has industries engaged in food processing, pharmaceuticals, plastics and chemicals etc. (Olarewaju et al., 2021). However, these businesses are encountering a more challenging environment in today's global, technologically-savvy and customer-centric business environment. Customers demand higher quality products, quicker delivery and greater value for money, at least not at a higher price. They require manufacturing SMEs to constantly seek improvement and create their capacity to compete effectively (Arli et al., 2024).

The strategic management literature has examined technological capabilities from different perspectives. In general, technological capability refers to a organisation's ability to acquire, build, integrate and apply technological resources in support of its business objectives (Cricelli et al., 2024). It therefore extends beyond the mere possession of computers, software or other technological tools (Cricelli et al., 2024). Recent studies have also recognised technological capability as a multidimensional construct, with different dimensions contributing to organisational performance in different ways (Fitz-Oliveira & Tello-Gamarra, 2024). In this study, technological capabilities comprise ICT infrastructure capability, digital marketing capability, process automation capability and innovation capability.

Competitive advantage, in essence, is the firm's ability to create more value than its rivals, or to perform in ways that give it a genuine edge within its industry (Rismayani et al., 2021). Firms strengthen that position by differentiating their products and services, lifting productivity, controlling costs and responding effectively to customer needs. Technology feeds into all of these outcomes, yet its value depends on how well it is woven into the firm's operations, which is precisely why operational efficiency is the link that carries technological capabilities through to competitive advantage. (Sharabati et al., 2024). Specifically, such proficiency in information and communication technology allows small- and medium-sized enterprises to optimize marketing operations and cultivate data-centric strategies that enhance overall financial performance (Yuwono et al., 2024).

The creation of a sustainable competitive advantage using technological capabilities is still a challenge for small and medium-sized manufacturing companies (Ferraro et al., 2025; Kareem et al., 2024). The issue is becoming increasingly apparent giving that investing in technology alone is not enough for increased performance,

particularly when it's not integrated into the company's daily business; having digital assets does not automatically translate into market success (Sassanelli et al., 2021; Silva et al., 2025; Noja et al., 2026). This is reflected in the prior research literature, yet converting them into a lasting competitive edge remains difficult for small and medium-sized manufacturing firms (Ferraro et al., 2025; Kareem et al., 2024).

Evidence links manufacturing technologies with operational advantage (Khanchanapong et al., 2014), but far fewer studies have asked whether it is the channel through which technological capabilities become competitive advantage (Amesho et al., 2022). That leaves us uncertain about how capability in ICT infrastructure, digital marketing, process automation and innovation, taken singly or together, actually shapes a firm's competitive position.

The problem is particularly acute among Nigeria's manufacturing SMEs, which often contend with limited access to contemporary technology and inadequate infrastructure (Duru et al., 2023; Sulaimon et al., 2024) side intense rivalry in the industry. Good evidence on what these capabilities actually deliver, and on whether operational efficiency mediates their effect, is therefore essential. The study attempts to address this by looking into the mediating role of operational efficiency between the technological capability of manufacturing SMEs in Lagos State, Nigeria and their competitive advantage.

II. Literature Review

Technological Capabilities in SMEs

In today's business world, where technology and market conditions is changing quickly, technological capabilities is now an important part of a company's ability to compete. A key indicator of a small or medium-sized business's technological capability is its ability to acquire, integrate, assimilate and use technological assets to improve its ability to respond to market needs, boost productivity, and come up with new ideas (Cricelli et al., 2024; Salisu & Bakar, 2019). This skill is especially important for small and medium-sized businesses in emerging countries, where they often have to deal with a lot of competition and not many resources. Firms that use technology well are able to improve their product quality, work more efficiently, and adapt to new customer needs (Cuandra & Candy, 2024). Additionally, technology can be used to address the limitations of small businesses by improving communication and collaboration, along with decision making power (Soni et al., 2021)

ICT Infrastructure Capability

Information and communication technology infrastructure capability is defined as a firm's ability to mobilise and deploy its ICT assets, which include computer hardware, software, networking technologies and information systems, in combination with other organisational resources to support its operations and objectives (Schreieck et al., 2021). The construct is broader than the equipment itself. IT capability is commonly understood to rest on three pillars: infrastructure, operations and knowledge (Sutrisno et al., 2023), so the physical components sit alongside the technical and organisational capacity needed to manage them, including data management systems and the personnel and processes that keep them running (Yoshikuni et al., 2023). In practical terms, the ICT infrastructure is the shared platform through which information is captured, stored, processed and communicated across the business (Caiazzo et al., 2022).

Digital Marketing Capability

Digital marketing capability is a firm's ability to engage customers, promote its products and manage market relationships through digital channels and technologies. The arrival of the internet and social media has reshaped what marketing means for small and medium-sized businesses, audiences that once had to be reached channel by channel can now be engaged instantly, and all at once. Firms that deploy digital marketing strategies, social media platforms, search engine optimisation and online advertising among others, can raise brand awareness, deepen customer engagement and reach new markets (Deku et al., 2024; Trainor et al., 2013).

Process Automation Capability

Process automation capability is the ability of a firm to perform administrative activities, production processes and provide services with minimal or no manual efforts through the use of technology (Kļaviņš, 2024). Efficient operation is grounded in output, process standardisation and minimisation of human error, and that is where automation technologies come in. Automation capabilities are especially important for small and medium-sized manufacturing businesses because industrial processes are technology-based. Empirical evidence has it that automation enhances manufacturing efficiency, reduces costs and boosts quality assurance (Abidemi, 2024). Similar to automation technologies, standardization of business processes, streamlining workflows, and operating the business more efficiently are other benefits that automation offers companies (Abidemi, 2024).

Innovation Capability

An organization's innovation capabilities can be defined as its power to create new value-enhancing goods, services, processes, or business frameworks that set it apart from competitors (Ahmad, 2021; Ndubisi et al., 2019). Strategic management literature generally agrees that the ability to innovate is critical to maintaining a competitive edge over the long run (Kareem et al., 2024; Joshua et al., 2021). This shows that companies with strong innovation skills always do better in the marketplace. Companies can adapt to changing market dynamics, launch new goods, and enhance operational procedures through innovation; this enables smaller businesses to compete with bigger firms while having fewer resources (Do et al., 2021).

Operational Efficiency

The capacity of a company to maximise output with little waste and expense is known as operational efficiency (Li et al., 2021). The most successful businesses manage to keep their prices low without lowering the bar on the quality of what they offer. Given the complexity of production processes, operational efficiency is of the utmost importance in industrial context. Businesses can better meet customer demands, cut costs, and improve product quality with more operational efficiency (Al-Najjar & Qandeel, 2025).

Linkages among Technological Capability, Operational Efficiency and Competitive Advantage

Operational efficiency is a firm's capacity to get the most out of what it has, turning out more while wasting less (Li et al., 2021). In practice it manifests as reduced waste without compromising quality or service, and often it is expressed in terms of the ratio between operational profit and operational cost. In a business that is most successful, the price is kept down without lowering standards, and in manufacturing, where processes are complex and interdependent, it is more important than in practically any other business. Efficient firms are better equipped to fulfil customers' demands, manage costs and improve product quality (Ataburo et al., 2024).

Research Gap

A good deal of prior work has linked technological capability to firm performance (Martínez et al., 2020; Olubiyi, 2022; Silva et al., 2025), yet the picture it leaves is still incomplete. Most studies have approached the construct one dimension at a time, ICT adoption in one, digital transformation in another, innovation initiatives in a third. Each lens yields useful insight, but none shows how the pieces work together, and the four dimensions examined here: ICT infrastructure, digital marketing, process automation and innovation, have rarely been brought together within a single framework (Fitz-Oliveira & Tello-Gamarra, 2024).

Operational efficiency is one of the most plausible channels, yet it remains underexplored as a mediator, especially among manufacturing SMEs in developing economies (Al-Omush et al., 2023; Bindeeba et al., 2025). The empirical evidence is weakest where the conditions are most different: in Sub-Saharan Africa, faced with infrastructure challenges, and with limited resources and rapidly changing technology environments (Achieng & Malatji, 2022).

These gaps are addressed directly in this study, which treats technological capacities as a multi-dimensional phenomenon that encompasses the availability of ICT infrastructure, digital marketing, process automation and innovation. It further investigates if operational efficiency acts as a mediating variable between the noted technological capacities and competitive advantage for manufacturing SMEs in Lagos State, Nigeria.

Theoretical Framework

Resource-Based View

The Resource based view provides a simple and powerful account of why some firms consistently outperform others: competitive advantage stems from resources that are valuable, rare, difficult to imitate and not easily substituted (Surin et al., 2023). Technological competencies are strategic resources when they are well developed and integrated into the company's operational routines. ICT infrastructure, digital marketing, process automation, and innovation can enhance productivity, decision-making, market responsiveness, and performance, but only when they are shown to be more than just equipment and software.

Dynamic Capabilities Theory

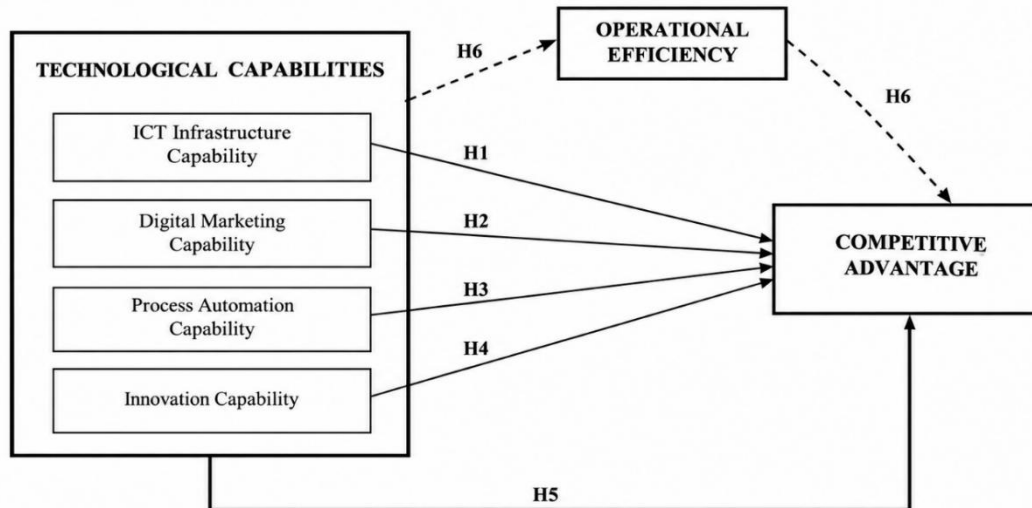
The theory starts from the premise that firms must be able to develop, integrate and reconfigure their resources as the environment changes, in addition to possessing them (Teece et al., 1997). The theory is sometimes presented as a supplement to the RBV because it accounts for firms' reactions to change in a context-dependent manner (as opposed to just listing their assets) (Wong & Ngai, 2021). This perspective highlights the firm's ability to leverage technology and evolve it as the need arises (Teece, 2018).

These two views complement each other when combined. RBV provides an answer to the question of why technological capabilities can be strategic assets, while Dynamic capabilities theory provides an answer to how these assets are used, renewed and converted into results.

Conceptual Model

The conceptual model proposes direct effects of ICT infrastructure, digital marketing, process automation and innovation capabilities on competitive advantage, a joint effect of technological capabilities, and an indirect pathway through operational efficiency. This reflects the argument that technology becomes strategically valuable when it is integrated into routines that improve speed, quality, cost control, coordination and responsiveness.

Figure 1. Conceptual Model



Source: Authors (2026)

Key:

Independent Relationship —————→
 Mediating Relationship - - - - -→
 Joint Relationship —————→

Hypotheses Development

H1: ICT infrastructure capability has a positive and significant effect on the competitive advantage of manufacturing SMEs.

H2: Digital marketing capability has a positive and significant effect on the competitive advantage of manufacturing SMEs.

H3: Process automation capability has a positive and significant effect on the competitive advantage of manufacturing SMEs.

H4: Innovation capability has a positive and significant effect on the competitive advantage of manufacturing SMEs.

H5: Technological capabilities have a positive and significant joint effect on competitive advantage.

H6: Operational efficiency mediates the relationship between technological capabilities and competitive advantage.

III. Methodology

Research Design

The study adopted a cross-sectional mixed-methods design. Quantitative survey data were used to test relationships among technological capabilities, operational efficiency and competitive advantage, while qualitative interviews provided contextual explanations. The quantitative data were analysed with SPSS version 26 using descriptive statistics, Pearson correlation, simple and multiple regression, and mediation analysis. Hayes' PROCESS Model 4 with 5,000 bootstrap samples and 95% confidence intervals was used to test the indirect effect; mediation was established when the bootstrap confidence interval excluded zero (Lau & Höyng, 2022).

Technological capabilities were represented by ICT infrastructure, digital marketing, process automation and innovation capabilities.

The qualitative phase was carried out between December 2025 and April 2026, with purposive sampling. The participants were chosen according to their first-hand experience in the use of technology, processes within their organisation and its competitive strategy (Benoot et al., 2016; Gentles et al., 2015). Qualitative respondents were selected from 3 manufacturing SMEs of the 3 sectors included in the quantitative survey: motor vehicle and miscellaneous assembly, electrical and electronics, and chemical and pharmaceutical. This facilitated the study to gain detailed views from 9 managers, two each from the three selected firms, who had relevant managerial or operational experience.

Interview data were analysed thematically through familiarisation, initial coding, clustering of related codes, theme review and refinement, and development of the interpretive account (Byrne, 2021).

The interviews explored participants' experiences of ICT infrastructure, digital marketing, process automation and innovation, their contribution to competitive advantage, the role of operational efficiency, and barriers to obtaining value from technological investments. With participants' permission, interviews were audio-recorded and transcribed verbatim. Transcripts were anonymised and stored securely for academic use. Follow-up questions and probes were used where clarification was required.

Study Area, Population and Sampling

The research was carried out in Lagos state, Nigeria, one of the major manufacturing centres in the country (Koko & Bello, 2023). The selection of the state was based on the fact that the manufacturing firms are clustered in various sectors of the economy and its relevance to Nigeria's industrial development. The study population consisted of 191 SMEs selected from the 3 selected manufacturing sectorial groups from Manufacturers Association of Nigeria Annual Report, (2024). These included chemical and pharmaceutical companies, electrical and electronics companies, and motor vehicle and miscellaneous assembly companies.

A sample size of 129 companies of the population of 191 SMEs was determined using the Taro Yamane formula. A multistage sampling procedure was then employed, involving sector stratification, proportional allocation and random selection. Three respondents were selected from each sampled firm, resulting in a total of 387 questionnaires distributed. Using multiple respondents from each organisation helped to reduce the potential for single-informant bias and provided a broader assessment of firm-level practices (Keller et al., 2021). Of the 387 questionnaires distributed, 298 were returned and considered valid for analysis, representing a response rate of 76.9%.

$$n = \frac{N}{1 + N(e)^2}$$

Where:

- n = sample size
- N = population size
- e = margin of error (0.05)

Substituting the population value:

$$n = \frac{191}{1 + 191(0.05)^2} = \frac{191}{1 + 191(0.0025)} = \frac{191}{1 + 0.4775} = \frac{191}{1.4775} \approx 129$$

Measurement of Variables

Validated multi-item measurement scales adapted from previous studies were used to measure the constructs in the study. All items were assessed using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The measurement model was assessed in terms of indicator reliability, internal consistency, convergent validity and discriminant validity.

ICT Infrastructure Capability was measured using six items adapted from (Bharadwaj, 2000). The items assessed the availability and reliability of internet connectivity, use of computer and digital systems for financial management and record keeping, access to secure digital payment systems, maintenance of updated hardware and software, the contribution of ICT systems to communication and coordination, and regular investment in ICT infrastructure. Digital Marketing Capability was measured using five items adapted from. The items assessed the firm's use of social media and other digital channels for marketing, analysis of online customer engagement, expansion of the customer base through digital marketing, responsiveness to customers through digital platforms, and the existence of a structured digital marketing strategy.

Process Automation Capability was measured using five items adapted from the literature on intelligent process automation and manufacturing automation, particularly (Lievano-Martínez et al., 2022). The items

assessed the use of automated systems in production or service delivery, reduction of operational errors and costs through automation, improvement in process efficiency, use of software for inventory and workflow management, and reduction in service delivery time. Innovation Capability was measured using six items adapted from (Çalik et al., 2017). The items assessed the firm's ability to introduce new or improved products or services, develop technology-enabled business models, encourage employees to generate new ideas, adapt to technological changes, invest in research and product development, and use innovation to differentiate the firm from competitors.

Operational Efficiency was measured using five items adapted from Zururi et al., 2025. The items assessed the speed of operational processes, technology-enabled operational efficiency, reduction of operational cost, efficient utilisation of organisational resources, process optimisation, and the overall efficiency of operational processes. Competitive Advantage was assessed using eight items based on Li et al., 2004 and Newbert, 2008. The products evaluated for their performance in the market, continued sales growth, consumer preference, market positioning, profit margin, responsiveness to market change, customer loyalties and overall competitive advantage in the industry. In general, the measurement items were adjusted to be applicable to the context of manufacturing SMEs, and the meaning of the constructs was preserved.

Reliability, Validity and Trustworthiness

The quantitative instrument consisted of validated multi-item scales from previous research. Cronbach's alpha was used to determine the internal consistency of the measurement scales. Cronbach's alpha coefficients ranged from 0.769 to 0.888, which is within the desirable range of 0.70 and above and signify acceptable internal consistency of measurement scales (Dunn et al., 2013; Panayides, 2013).

In the qualitative strand of the research, methods used to ensure trustworthiness were careful selection of participants, systematic and transparent coding process, audit trail, anonymous participants and comparison of themes in interviews (Ang et al., 2016). Semi-structured interviewing also allowed respondents to offer detailed responses to experiences and ensured that the essential content areas that were outlined as our research questions were discussed in every interview.

Common Method Bias

Harman's single factor test was conducted to check for the common method bias. The Principal Component Analysis of the items measured revealed that a first component explained 27.902% of the total variance. This ratio falls within the range below 50%, which is the ratio generally used as an indicator of the prevalence of common method bias and so there was no single factor which accounted for the majority of the variance, indicating that common method bias is unlikely to dominate the findings (Chang et al., 2010; Tehseen et al., 2017).

Ethical Considerations and Informed Consent

The study was carried out as an independent academic research project. The participants were informed about the purpose of this study, their role, and the academic application of the information they provide before the data collection process. The participants gave their informed consent before they took part in this study, which was conducted without any threats to the participants.

To protect participants' privacy, no personally identifying information was disclosed in the reporting of the findings. Participants' responses were anonymised and the information collected was confidentially used only for academic research. Participants who agreed to an interview were briefed on the recording and use of their responses for the purposes of transcription and thematic analysis.

IV. Results

In this analysis, the respondents' characteristics, descriptive statistics, reliability analysis, Pearson correlation analysis, regression analysis of individual effects of technological capabilities, regression analysis of joint effects of the four dimensions and regression analysis of the mediation of operational efficiency are analyzed. 298 valid observations were used to make the final analysis.

4.2 Profile Characteristics of Respondents

Table 2. Socio-Demographic Characteristics of Respondents

Sectorial Group	Frequency	Percentage
Motor Vehicle and miscellaneous assembly	99	33.22%
Electrical and electronics sectorial group	92	30.87%
Chemical and pharmaceutical sectorial group	107	35.91%
Number of Employee	Frequency	Percentage
1-9	110	36.91%
10 – 49	99	33.22%
50 – 199	89	29.87%
Years in Operation	Frequency	Percentage

Less than 3 years	88	29.53%
3 – 5 years	76	25.50%
6 – 10 years	69	23.15%
Above 10 years	65	21.81%
Ownership Type	Frequency	Percentage
Sole proprietorship	96	32.21%
Partnership	101	33.89%
Limited liability company	101	33.89%

Source: Researcher's Compilation, 2026

Table 2 presents the distribution of respondents across the demographic variables contained in the dataset. The profile characteristics show a fairly balanced representation of the manufacturing SMEs studied. The chemical and pharmaceutical sector had the highest representation (35.91%), followed by motor vehicle and miscellaneous assembly (33.22%) and electrical and electronics (30.87%). In terms of firm size, enterprises with 1–9 employees constituted the largest group (36.91%). Regarding years in operation, firms operating for less than three years were the most represented (29.53%). Finally, partnerships and limited liability companies each accounted for 33.89%, while sole proprietorships represented 32.21%, indicating a relatively even distribution of ownership types.

Descriptive Statistics

The descriptive statistics in table 3 indicate generally favourable assessments of the study constructs. Innovation Capability recorded the highest mean score ($M = 4.31$, $SD = 0.47$), followed by Operational Efficiency ($M = 4.09$, $SD = 0.25$), Digital Marketing Capability ($M = 4.01$, $SD = 0.52$), Competitive Advantage ($M = 4.01$, $SD = 0.33$), Process Automation Capability ($M = 3.89$, $SD = 0.46$), and ICT Infrastructure Capability ($M = 3.86$, $SD = 0.41$). Cronbach's alpha was used to assess internal consistency. All constructs exceeded the commonly accepted .70 threshold (Rafique et al., 2024), indicating satisfactory reliability. The reliability results show that all six constructs achieved acceptable internal consistency, as all Cronbach's alpha values are above the commonly accepted threshold of 0.70. The alpha values range from 0.769 to 0.888, indicating that the measurement items consistently measure their respective constructs. Therefore, all items were retained for subsequent analysis. The correlation analysis revealed positive and statistically significant relationships among all the study variables, with correlation coefficients ranging from 0.252 to 0.468. This indicates weak to moderate positive associations, suggesting that improvements in technological capabilities are generally associated with higher operational efficiency and competitive advantage.

Table 3 Statistics Summary and Correlation Significance

Variable	Mean	S.D	α	1	2	3	4	5
1. ICT Capability	3.860	0.412	0.784					
2. DMC Capability	4.012	0.525	0.825	.380**				
3. PAC Capability	3.893	0.459	0.794	.279**	.392**			
4. IC Capability	4.312	0.466	0.827	.352**	.433**	.349**		
5. Operational Efficiency	4.086	0.246	0.769	.449**	.468**	.444**	.434**	
6. Competitive Advantage	4.008	0.332	0.888	.252**	.438**	.281**	.345**	.384**

Regression Analysis and Hypothesis Testing

Individual Effects of Technological Capabilities on Competitive Advantage

The regression results in table 4, show that the four dimensions of technological capability have positive and significant effects on competitive advantage. All four technological capabilities (ICT Capability, Digital Marketing Capability, Process Automation Capability and Innovation Capability) have positive beta coefficients, and the associated t-values all show a significant effect. The R^2 values indicate that the individual capabilities account for between 2.1% and 10.7 % of the variance in competitive advantage; in other words, ICT Capability accounts for the maximum variance of competitive advantage. The overall results confirm the proposed positive relationships of the technological capabilities with the competitive advantage as stated in H1, H2, H3 and H4).

Table 4 Regression analysis of Individual Effects of Technological Capabilities on Competitive Advantage

Relationship	Predictor	B	t	P	R^2	Decision
ICT Capability → Competitive Advantage	ICT Capability	0.328	5.966	<.001	0.107	Supported
DMC Capability→Competitive Advantage	DMC Capability	0.301	5.425	<.001	0.090	Supported
PAC Capability → Competitive Advantage	PAC Capability	0.144	2.496	0.013	0.021	Supported

IC Capability → Competitive Advantage IC Capability 0.278 4.974 <.001 0.077 Supported

Joint Effect of Technological Capabilities on Competitive Advantage

Table 5 Regression analysis of the Joint Effect of Technological Capabilities on Competitive Advantage

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.454a	.206	.203	.70259

ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	37.921	1	37.921	76.821	.000b
	Residual	146.115	296	.494		
	Total	184.037	297			

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.226	.216		5.678	.000
	Technological_Capabilities	.613	.070	.454	8.765	.000

a Dependent Variable: Competitive_Advantage
Source: Field Survey, 2026

In Table 5, regression analysis was conducted to test the joint effect of the technological capabilities on competitive advantage. According to the model summary, the R value is 0.454, which suggests that there is a moderate positive relationship between technological capabilities and competitive advantage. The R² value of 0.206 suggests that technological capabilities account for 20.6% of the variance in competitive advantage and the variance not explained by the technological capabilities is 79.4%. The adjusted R² of 0.203 also indicates that the model is a reasonably good explanation of the variation in the dependent variable.

From the ANOVA result, regression model is statistically significant as the F-value is 76.821 and p value is 0.000 which is less than the significance level 0.05. This means that the regression model is viable and statistically significant, technological capabilities have an impact on competitive advantage. The coefficient result further shows that technological capabilities have a positive and significant effect on competitive advantage, with B = 0.613, $\beta = 0.454$, t = 8.765, and p = 0.000. The positive beta coefficient implies that an increase in technological capabilities is associated with an increase in competitive advantage. Specifically, a one-unit increase in technological capabilities is associated with a 0.613-unit increase in competitive advantage. Since the p-value is below 0.05, the effect is statistically significant.

Therefore, the result indicates that technological capabilities significantly and positively influence competitive advantage, explaining 20.6% of its variation.

Mediation Analysis of Operational Efficiency

Table 6 Regression analysis summary for mediation of operational efficiency between technological capability and competitive advantage

Mediation Path	Effect (β)	SE	T	p-value	95% Bootstrap CI	Decision
Technological Capabilities → Operational Efficiency (a)	0.7025	0.0526	13.3521	<0.001	[0.5989, 0.8060]	Significant
Operational Efficiency → Competitive Advantage (b)	0.2020	0.0766	2.6383	0.0088	[0.0513, 0.3527]	Significant
Total Effect (c)	0.6135	0.0700	8.7647	<0.001	[0.4757, 0.7512]	Significant
Direct Effect (c')	0.4716	0.0877	5.3760	<0.001	[0.2990, 0.6442]	Significant
Indirect Effect (a × b)	0.1419	0.0562	—	—	[0.0371, 0.2596]	Significant
Completely Standardised Indirect Effect	0.1050	0.0422	—	—	[0.0271, 0.1942]	Significant

Source: Field Survey, 2026

The mediation analysis in table 6 indicates that technological capabilities significantly predict operational efficiency ($\beta = 0.7025$, $p < 0.001$). Operational efficiency also has a significant positive effect on Competitive Advantage ($\beta = 0.2020$, $p = 0.0088$). The total effect of technological capabilities on competitive advantage was significant ($\beta = 0.6135$, $p < 0.001$). After operational efficiency was introduced into the model, the direct effect remained significant ($\beta = 0.4716$, $p < 0.001$), although it decreased from the total effect of 0.6135. This reduction indicates that part of the effect of technological capabilities on competitive advantage operates through operational efficiency.

The indirect effect of technological capabilities on competitive advantage via operational efficiency was most important with its value being 0.1419. The 95% bootstrap confidence interval ranged from 0.0371 to 0.2596. This is because the indirect effect does not include the value of zero in the confidence interval. Thus, the influence of technological capabilities on competitive advantage is partially mediated by Operational efficiency. The mediator does not completely remove the direct effect, so it is not a full mediation. As a result, the H6 is supported.

Table 7 Summary of Hypothesis Testing

Hypothesis	Decision
H1: ICT Infrastructure Capability → Competitive Advantage	Supported
H2: Digital Marketing Capability → Competitive Advantage	Supported
H3: Process Automation Capability → Competitive Advantage	Supported
H4: Innovation Capability → Competitive Advantage	Supported
H5: Technological Capabilities → Competitive Advantage (joint effect)	Supported
H6: Operational Efficiency mediates Technological Capabilities → Competitive Advantage	Supported

Qualitative Findings

The qualitative phase explained how technological capabilities were experienced in the participating manufacturing SMEs and provided contextual insight into the quantitative relationships. Thematic analysis produced the following themes.

ICT Infrastructure Capability and Competitive Advantage

The need for ICT infrastructure to enhance communication, information accessibility, coordination, and responsiveness were a common feature in the interviews. Participants defined ICT infrastructures as including computers, Internet access, digital communication systems, enterprise software, mobile technologies, and other technology tools to assist in business operations.

Reliable ICT systems were reported to reduce communication delays with customers, suppliers and employees, while digital records made transaction information easier to retrieve for decisions.

“Reliable Internet and Computer systems “has sped up communication with customers and suppliers so that their enquiries and issues can be addressed quickly instead of waiting for the information to be passed on from one person to another”. (Participant)

The second challenge that was put was the role of ICT in enhancing access to business information. They described how digital records and information systems helped them to find customer information, track transactions, compile reports and make decisions. This was especially relevant when enterprises used to have a lot of paper work.

“Before, when we wanted to know about a transaction from the past, it would take time to find the information; now, it is available when needed, making it easier for the management to make decisions; we aren't relying totally on memory of one person to remember what happened.” (Participant)

Participants also linked stronger ICT infrastructure to faster responses to customer, market and supplier issues. However, ICT infrastructure did not automatically produce competitive advantage; poor connectivity, unstable electricity, high technology costs and limited technical support could restrict its value. Overall, the qualitative evidence suggests that ICT capability supports competitive advantage through communication, information access, coordination and responsiveness, providing contextual support for H1.

Digital Marketing Capability and Competitive Advantage

Digital Marketing's role in market visibility, customer acquisition, customer retention and sales support was discussed. They spoke about the use of social media platforms, websites, messaging apps, online advertisements, and other digital tools to market products and engage with their customers.

A point of commonality was also that digital marketing helped the SMEs to target customers outside of their local areas. Participants found that digital platforms helped firms to showcase their products to a larger number of people other than physical marketing activities.

“Social media allows our customers to see what we are doing, even if they weren't aware of our products before.” (Participant)

Participants also mentioned the fast spread of information via digital marketing. Instead of relying on traditional advertising methods to reach customers, companies could launch new products, promote sales, answer customer questions, and get feedback from customers almost instantly.

The interviews also indicated that digital marketing offered SMEs the opportunity to promote closer relationships with their customers. Participants shared that customers could directly send messages to companies on social media and messaging applications and ask questions, give feedback, and make product inquiries.

“Customers are contacting us directly on social media, we can respond to their questions promptly and are aware of what they are searching for; their comments tell us what products they are interested in and sometimes this influences our marketing and the products we offer.” (Participant)

A consistent online presence was viewed as a relatively accessible way for smaller firms to compete for customer attention. Constraints included advertising costs, content-creation skills, difficulty measuring returns on digital marketing and sustaining online engagement. Thus, digital marketing capability supported competitive advantage through visibility, customer engagement, rapid communication and wider market access, providing contextual support for H2.

Process Automation Capability and Competitive Advantage

The third theme was concerned with the automation of processes and the role it played in improving efficiency, consistency, speed and minimizing manual process. Participants shared their ideas on the automation of the use of technology for record keeping, inventory, accounting, production monitoring, sales processing, communication, and other repetitive tasks.

One of the major advantages that participants reported was the saving of time in repetitive activities. Automation helped workers to accomplish some tasks faster and also minimized reliance on manual methods.

“Some tasks, which previously took hours, can now be carried out much quicker, thanks to the system doing the work for the employee; he doesn't have to enter the same data into the system several times, giving him more time to focus on other tasks.” (Participant)

Automation was also perceived to reduce manual errors and standardise routine processes. Technology-enabled monitoring of inventory, sales and production gave managers quicker information for corrective action. Faster order and transaction processing also supported more timely customer service. However, high acquisition costs, employee resistance, limited expertise and integration difficulties could constrain automation.

The qualitative results also suggest that process automation can help achieve competitive advantage by speeding up processing, minimising error, maintaining consistency, better monitoring and more use of organisational resources. These results support H3.

Innovation Capability and Competitive Advantage

The other key theme that arose out of the interviews was innovation capability. The responses under the term innovation ranged from new or improved products, process change in production, service improvement, adapting to changing customer preferences, and new ways of doing business.

One of the important results was that the competitive advantage was not seen as being maintainable only by the products and processes that were already in place. Participants highlighted the importance of continuously upgrading and adjusting to the changing needs of customers and market conditions.

“Customers' needs evolve and if you don't keep up with them, others can catch up with you, you need to understand what they're asking for and how you can better your product and service: innovation is key.” (Participant)

Technological knowledge and access to information can enable innovation, by supporting companies in discovering new products, new production methods, new materials, and new market opportunities. Technologies thus seemed to facilitate innovation both directly and indirectly, in terms of providing access to information and facilitating experimentation.

Another clear indicator of innovation capability was the improvement of products. The respondents indicated that firms could adapt their product to customers and/or develop new product features to out-compete rivals.

Process innovation was similarly regarded as important. Participants talked about the improvement of production methods, reduction of waste, improvement of product quality, and simplification of the operational procedure. These enhancements may enable companies to cut down on expenses without compromising product quality or reducing it.

The results also showed that organisational culture is a factor affecting innovation capability. Managers who were open to new ideas and employees who were encouraged to share ideas were seen as beneficial to the firms. At the same time, a lack of willingness to change might restrict technological opportunities to the amount of innovation that was realized.

Overall, innovation capability supported competitive advantage through differentiation, process improvement, responsiveness and adaptability, providing contextual support for H4.

Operational Efficiency as the Linking Mechanism

Operational efficiency emerged as the principal mechanism through which participants believed technological capabilities generated competitive benefits. Technology was considered strategically valuable when it improved day-to-day operations.

Technology use was linked to a reduction in processing time, better use of resources, lower error rates, better coordination, quicker decision making and better customer. These operational enhancements were then connected to competitiveness in terms of reduced costs, quality improvement, quicker delivery and higher customer satisfaction.

"It is not about the technology; it's about what we can do better with technology, be it saving time, making fewer mistakes, or serving customer more quickly. If we purchase technology, but our processes are slow, then that technology isn't providing us with that much of an advantage." (Participant)

This point of view is a key explanation for the mediation relationship explored in the quantitative phase. ICT infrastructure, digital marketing, automation and innovation capacities could offer the resources and capacities needed for technological transformation, but operational efficiency is one important avenue for generating competitive results.

For instance, the development of the ICT infrastructure can promote faster exchange of information, better exchange of information can help to coordinate better, better coordination can help to minimize delays, and minimize delays can help provide better customer service and competitive positioning. Likewise, improved customer information can help firms respond appropriately to demand; and digital marketing can help to expand customer reach. Process automation can eliminate processing time and errors, and innovation can enhance products and processes. In all instances, the increase in operating efficiency will be the link between technological capability and competitive advantage.

Participants also underscored the importance of operational efficiency to go beyond cost savings. It incorporated effective use of available resources without compromising quality and meeting customer expectations.

The qualitative evidence therefore explains the perceived mechanism underlying H6; it complements, rather than independently establishes, the statistical mediation result.

Constraints to Effective Technology Utilisation

Participants identified cost, infrastructure limitations, electricity supply, employee skills, resistance to change, cybersecurity concerns and limited technical support as barriers to effective technology utilisation. Technology acquisition and maintenance cost was often cited as an issue. Participants reported that the cost and expense associated with acquiring hardware, software, subscription, maintenance and Internet access could be significant for SMEs.

"The challenge is not always knowing what technology is required, it can also be if the business can afford to purchase and maintain it, as well as if they can afford to upgrade and train employees to use it correctly." (Participant).

Unreliable electricity and internet connectivity could interrupt technology-dependent management and production activities. Participants also stressed that insufficient employee skills and resistance to new systems could reduce the value of technological investments.

"The introduction of a new system is not sufficient: the employees need to be familiar with the new system and to adapt to it, or else the investment might not pay off. Some people are not accustomed to the new approach and may be hesitant at first to change, so management needs to offer training and support". (Participant)

The emergence of cybersecurity and data protection was also noted, especially with the increasing use of digital platforms and electronic records by companies. Participants were aware of the risks of unauthorised use, information theft and online fraud.

These findings indicate that the competitive value of technological capability depends on infrastructure, skills, financial resources, management support and organisational readiness.

Integration of Quantitative and Qualitative Findings

The quantitative results established positive relationships between technological capabilities and competitive advantage, while the qualitative evidence explained how these relationships were experienced in practice. Across the interviews, the capabilities appeared complementary: ICT infrastructure supported information and digital marketing activities, automation improved technology-enabled processes, and innovation helped firms apply technology to products and operations. Operational efficiency was the central point of convergence. The significant quantitative indirect effect was reflected in participants' accounts linking technology

to faster processes, fewer errors, better cost control, quality, customer responsiveness and more efficient resource use. The qualitative strand also identified contextual constraints particularly finance, infrastructure, employee skills, change management and technical support, that can determine whether technological investments produce expected benefits.

Taken together, the findings suggest that technological capabilities are more likely to create competitive value when they are integrated into organisational processes and translated into operational improvements.

V. Discussion

ICT Infrastructure Capability and Competitive Advantage

The positive effect of ICT Infrastructure Capability indicates that ICT is a strategic resource when embedded in organisational processes. ICT supports information sharing, coordination, decision making and responsiveness (Troise et al., 2021), consistent with Bharadwaj's (2000) resource-based evidence linking IT capability with firm performance. Recent work similarly suggests that ICT capability creates value through agility, resilience and effective resource deployment (Trieu et al., 2023). For manufacturing SMEs, these mechanisms can improve information flow and coordination of production activities.

Digital Marketing Capability and Competitive Advantage

Digital Marketing Capability had a significant positive effect on competitive advantage, indicating that strategic use of digital channels can strengthen market reach, customer engagement and responsiveness. This aligns with Trainor et al. (2013) and Taiminen and Karjaluoto (2015). However, Purwanti et al. (2022) reported no significant relationship in another MSME context, suggesting that complementary capabilities and environmental conditions may influence the strength of the effect.

Process Automation Capability and Competitive Advantage

Process Automation Capability had a positive but comparatively modest effect on competitive advantage. Automation can improve consistency, productivity and error reduction, consistent with evidence from manufacturing SMEs (Valdez-Juárez et al., 2024). Its value may be greater when integrated with existing processes and organisational routines rather than implemented as a stand-alone technology (Csiki et al., 2023).

Innovation Capability and Competitive Advantage

Innovation Capability positively affected competitive advantage, indicating that SMEs able to develop and implement new products, processes and business practices are better positioned to differentiate and respond to market change. This supports Sulisty and Ayuni (2019) and Widyanti and Mahfudz (2020). Nevertheless, evidence is context-dependent; Rosenbusch et al. (2010) identified variation across SME settings.

Joint Effect of Technological Capabilities on Competitive Advantage

The significant joint effect demonstrates that technological capabilities should be viewed as a portfolio of complementary organisational capabilities rather than isolated technological investments. Together, ICT infrastructure, digital marketing, process automation and innovation capability explained 21.3% of the variance in competitive advantage. This supports the multidimensional conceptualisation of technological capabilities adopted in the study and is consistent with the Resource-Based View. The result is also broadly consistent with Bharadwaj (2000), whose work shows that technology capability can be a firm-level strategic resource, and with the SME literature showing that combinations of technology, innovation and marketing capabilities can contribute to stronger competitive outcomes (Nikmah et al., 2024; Olubiyi, 2022). At the same time, the finding should not be interpreted as evidence that every technological capability will always produce a strong competitive effect. The contrasting evidence on ICT capability, for example, shows that technology may fail to generate direct competitive advantage when key complementary organisational capabilities are weak (Hervás-Oliver et al., 2020). Thus, the significant joint effect in our study may reflect the complementary nature of the four capabilities when they are deployed together within manufacturing SMEs.

Mediating Role of Operational Efficiency

The finding that operational efficiency mediates the relationship between technological capabilities and competitive advantage indicates that the competitive benefits of technology are partly realised through improvements in the way firms conduct their operations. Technological capabilities enable firms to improve the utilisation of resources, streamline processes, enhance productivity and respond more effectively to operational demands. These improvements in operational efficiency can subsequently strengthen the firm's ability to compete through better quality, responsiveness, cost management and service delivery. Thus, technological capabilities may create competitive advantage not only through their direct strategic value but also through their contribution to more efficient organisational operations (Tong et al., 2022). This result aligns with the latest literature on digital

transformation and competitiveness of SMEs. In particular, this mediation mechanism highlights that technological capabilities create value by optimising operational functions and thus create a distinct market position for a business (Sastryawanto et al., 2024).

This is in line with the research, which showed that the SMEs that use digital technologies, platforms and tools need to build up internal capacities to gain the benefits of such investments for operational excellence (Rajala & Hautala-Kankaanpää, 2023).

Overall, the research builds on previous studies to show that technological capabilities can be a source of competitive advantage, at least in terms of operational efficiency for manufacturing SMEs. It implies that just having ICT infrastructure, digital marketing tools, automation technologies or innovation capabilities is not enough to create competitive benefits. It is imperative that these capabilities become part of SMEs' daily business processes to ensure investments in technology translates into more efficient processes and ultimately better competitive positioning.

Mixed-Methods Integration

The quantitative and qualitative data presented a more holistic picture of the relationship between the technological capabilities, operational efficiency and competitive advantage of manufacturing SMEs in Lagos State, Nigeria. It can be said that the quantitative analysis was used to identify the direction, magnitude and statistical significance of the relationships that were being tested in the study while the qualitative strand was used to give contextual information as to how the relationships are experienced and interpreted into organisational outcomes. Thus, the two strands complement each other, with the quantitative evidence providing a basis for determining if the relationships are observed, and the qualitative evidence providing an explanation for how and why the relationships are observed in practice.

The qualitative themes generally support the positive relationships found in the quantitative analysis. The accounts of the participants show that ICT infrastructure, digital marketing, process automation and innovation are not only technological resources but are perceived as a way to enhance the way manufacturing SMEs coordinate activities, interact with customers, manage information, perform production activities, and react to market developments. The enhancements offer practical explanations for the positive impact of each of the technological capability dimensions on competitive advantage.

Theoretical Contributions

The results add four important contributions to the literature. First, they provide empirical evidence for the RBV, which is still limited in certain environments: technological capabilities were valuable and hard-to-replicate and were positively correlated with competitive advantage (Cricelli et al., 2024). Second, they build on Dynamic Capabilities Theory by highlighting the value of technological resources realised through reconfiguration, and improved operational processes, which are the mechanisms that Improves technology performance, as evidenced by the fact that the value of dynamic capabilities is often realised through mediating mechanisms. Thirdly, they consider technological capability in multiple ways, seeing ICT infrastructure, digital marketing, process automation and innovation side-by-side in one framework and the partial mediation effect confirms that competitive value is created by the synergies of combinations of complementary capabilities (Angelia et al., 2025). Last, the mediation finding reinforces the picture: not only do firms have these technological capabilities, but the firm's operations can transform them into performance.

Managerial Implications

The results have a relatively clear outcome for manufacturing SME managers: Technology decisions are strategy decisions. Purchasing hardware, software, or automation does not necessarily equate to building capacity; indeed, the companies that gained the greatest benefit from technology were those that incorporated it into their operations (as per the evidence that organisational capabilities pay off only when they are embedded in processes (Najjar & Qandeel, 2025)). Innovation capability is relatively powerful in influencing the course of innovation, indicating that it warrants explicit management attention. This could involve building an atmosphere of experimentation and continuous improvement, akin to what is observed in exceptional conditions, and investing in research and development when budget permits, as well as encouraging employees to suggest enhancements (Canbul & Çemberci, 2023).

However, an effective presence on social media and online platforms can increase brand visibility, strengthen customer relationships, and expand the market, particularly when driven by customer and market information, rather than just by the presence of an account (Rahman & Mardiana, 2024). Consequently, brand managers should not consider technology acquisition and process improvement as two separate projects, but rather as two parts of the same project, which are most effectively acquired when they increase the use of resources, coordination of the work process and productivity, as measured by operational efficiency (Triwahyono et al., 2023).

Policy Implications

Policy can, and should, play a real part in this, since many of the obstacles to manufacturing SMEs, such as limited capital, lack of digital skills and inconsistent infrastructure, are structural and not managerial. The results indicate that programmes to enhance access to technology and digital knowledge can directly impact on the productivity and competitiveness of SMEs (Ahmadu et al., 2025). The same conclusion can be drawn from studies on the adoption of ICTs by SMEs in Nigeria, which highlight that cost and skills and infrastructure influence a firm's ability to use ICTs in a productive manner (Apulu & Latham, 2011; Unegbu et al., 2024).

The results indicate that targeted credit facilities and subsidised technology programmes and technical support are worthy of consideration for many SMEs since they cannot afford to invest in the digital infrastructure and automation systems identified in the results (Ahmadu et al., 2025). Capacity building is also important, in addition to finance: Training in skills related to digital and data use, data analytics and innovation management would help companies make the most of the technologies they are adopting. Improved interaction between universities, research institutions and SMEs could also facilitate the diffusion of technology, as firms could benefit from access to technical knowledge, and research from a focus on real industry challenges.

VI. Conclusion

The aim of this study was to test the proposition that technological capability, broadly conceptualised as ICT infrastructure, digital marketing, process automation and innovation, can help manufacturing small and medium enterprises (SMEs) compete, and that part of the help can come from manufacturing's operational efficiency. The proposition is supported by the evidence from manufacturing SMEs in Lagos State. All four capabilities had a significant positive impact on the competitive advantage; the combined effect was significant, and operational efficiency acted as a mediator between the two, while also having a direct effect, the direct effect of which was significant in addition to the indirect effect.

The qualitative evidence builds upon the statistical results by providing insight into the process of how technological capabilities are manifested in the competitive outcomes in the day-to-day operations of manufacturing SMEs. In particular, the accounts of participants indicate that, operational efficiency, which is manifested as faster processes, better coordination, fewer errors and costs, better use of resources, and a higher degree of responsiveness to customers is a key factor in improving competitiveness through the use of ICT infrastructure, digital marketing, process automation, and innovation. Therefore, the qualitative results offer practical understanding of the mechanism connecting the quantitative mediation result as technological capabilities are made relevant in the operational processes and transformed into efficiency gains. In the real world, technology offers competitive value when it is embedded in the operations of the firms, not as an end to itself. Building capability for manufacturing SMEs is not just about acquiring tools, it also requires building the skills, routines and process that make them better performers, and is ongoing as markets evolve.

VII. Recommendations

1. SME owners need to focus more on their ICT infrastructure, which would involve the adoption of ICT software and hardware, including communication systems and information management systems that can facilitate their day-to-day operations and enable them to adapt to shifts in their business landscape in a timely manner.
2. Owners and employees of manufacturing SMEs need to be equipped with practical knowledge of digital marketing tools to help their businesses reach customers better, build customer relationships and boost sales, which can be achieved by enhancing their digital marketing capabilities.
3. SMEs should invest in automation solutions based on their real production needs, firms need to look at the automation that will help to lower unnecessary costs, enhance production speed and minimise errors in their specific production.
4. Technology should not be used solely as a management tool and managers should also consider how the work is organised, how resources are used, and where unnecessary delays and waste can arise. Enabling these processes and technology can help firms to get more value from investments.
5. Industry associations should offer frequent and hands-on training on digital skills to SME owners and employees. These programmes can be used to assist employees in acquiring knowledge to use technological tools effectively, especially if there is a lack of internal technical knowledge.
6. Technology, skill and process enhancement should be understood and implemented together and not as individual measures for SMEs. This can help prevent technology investments from just becoming another cost without impact on the business.

Contributions to Knowledge

The study contributes to the literature in two ways. The first one is empirical in nature. It offers empirical evidence from an under-researched context that technological capabilities: ICT infrastructure, digital marketing, process automation and innovation, are capable of being considered and used as a valid strategic resource for

manufacturing SMEs as a bundle and as a single unit. This bolsters the central tenet of the Resource-Based View (Barney, 1991; Bharadwaj, 2000) that is, that resources used by a firm can provide a basis for a competitive advantage.

The second contribution is on the mediator. The study demonstrates that competitive payoff is dependent on how firms utilize their technology, not just the ownership of the technology but that operational efficiency is a key partial mediator which provides researchers with a more concrete description of how technological capabilities evolve to become competitive results within resource-constrained environments.

Limitations and Future Research

Due to the cross-sectional design of this study, it cannot trace the development of technological capabilities nor the performance effects that follow over the longer term; rather, that design more naturally would be suited to longitudinal designs. Also, the results apply to the Lagos State context as institutional and economic situations vary from one region to another. Although the multi-respondent design does contribute to that effort.

These limitations have led to a number of implications. The use of longitudinal studies would provide information on the changes in technological capability and the resulting changes in performance over time. Moderating factors should also be explored: organisational culture, managerial competency and environmental uncertainty are all potential factors that could influence the value firms can deliver from their technologies, and prior research has already looked into the effects of organizational culture on technological capability in the context of SME growth (Putri, 2026). An extended geographic region would help to explain the influence of institutional environments on capability building, and other mediators (e.g. innovation outcomes, digital maturity and organisational knowledge acquisition) could be explored in future research. Lastly, industry-specific research, especially in service and technology companies, would provide a more fine-grained understanding of how technological capabilities are operating in various types of businesses.

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