

Resource-Based Competencies and Digital Maturity: A Synergistic Approach to Enhancing SME Operational Efficiency in Sub-Saharan Africa

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Research Article

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Abstract

Although digital maturity offers transformative potential for SMEs, many in Sub-Saharan Africa (SSA) fail to realise proportional efficiency gains due to weak internal competencies. This study examines how resource-based and dynamic capabilities interact with digital maturity to enhance operational efficiency. Guided by an integrative theoretical framework that combines the Resource-Based View (RBV), Dynamic Capabilities Theory (DCT), the Technology–Organisation–Environment (TOE) framework, and complementary behavioural and institutional perspectives, the study employs a predictive cross-sectional design using Partial Least Squares Structural Equation Modelling (PLS-SEM). Data were collected from 9,826 SMEs across thirteen SSA countries. The findings reveal that digital maturity significantly improves operational efficiency, with innovation capability and strategic alignment as mediators. Agility and institutional pressure amplify the digital–efficiency relationship. The study offers a contextualised, empirically validated model for SME digital transformation in resource-constrained environments. Though internal competencies and top-management support do not significantly moderate the digital-performance nexus, agility and institutional pressures amplify the transformative impact of digital maturity. SME digital strategies should prioritise capability development alongside technology deployment. Policymakers should design supportive regulatory and capacity-building frameworks, while technology vendors and financial institutions align products with firms’ absorptive capacities and agility levels. This study offers a novel, empirically validated model of SME digital transformation tailored to low-resource, high-uncertainty environments. By conceptualising digital maturity as a dynamic, capability-driven process, it advances theory and provides actionable insights for strategic capability building in digitally evolving SMEs.

JEL Classification: L25, L26, M25, O31, O33

1.0 INTRODUCTION

The rapid proliferation of digital technologies presents Small and Medium-Sized Enterprises (SMEs) with unprecedented opportunities to improve operational efficiency, market agility, and competitiveness. Digital maturity, defined as the systematic integration and strategic use of digital technologies in organisational processes, has become a decisive differentiator in contemporary business environments (Kane et al., 2017; Westerman & Bonnet, 2018). Yet, the success of digital transformation extends beyond technology acquisition, it depends fundamentally on firms’ internal resource-based competencies, including digital literacy, managerial expertise, innovation capability, and organisational adaptability (Warner & Wäger, 2019).

Empirical evidence indicates that the relationship between digital maturity and operational efficiency is not unidirectional but self-reinforcing: efficiency gains enable further digital investment, creating a virtuous cycle of capability deepening. Nonetheless, despite growing digital investment, significant disparities persist in SMEs’ performance outcomes, suggesting that the benefits of digital maturity are not uniformly realised. These variations call for deeper investigation into how internal resource-based competencies amplify, or constrain, the efficacy of digital transformation.

The uneven outcomes of digital initiatives are frequently attributed to SMEs’ neglect of complementary internal competencies—technological literacy, adaptive leadership, and innovation capacity—that underpin successful digital transformation (Matt et al., 2015; Warner & Wäger, 2019; Verhoef et al., 2021). The absence of these enablers leads to misalignment between digital strategy and execution, under-utilisation of technology, and ultimately suboptimal operational efficiency. Firms lacking robust internal capabilities also tend to experience widening digital-maturity gaps, falling progressively behind their digitally proficient peers (Kane et al., 2017).

Recognising the centrality of internal resource-based competencies in determining the success of SME digital transformation, this study seeks to answer several interrelated questions: How do variations in digital literacy and technological skills influence digital maturity and operational efficiency? To what extent do adaptive managerial competencies mediate the link between digital technology adoption and efficiency? How do strategic innovation capabilities and organisational agility moderate the effectiveness of digital investments under dynamic market conditions? Addressing these questions forms the specific objectives of this study.

This study contributes both theoretically and practically by deepening understanding of how internal resource-based competencies interact with digital maturity to shape SME performance. It empirically validates an integrated conceptual framework (Fig. 1) across high- and low-digitalisation as well as high- and low-technology-intensity contexts in Sub-Saharan Africa. The model illustrates how institutional pressures and sectoral technological depth condition the magnitude of digital-maturity effects. For researchers, it extends strategic-management and organisational-capability theories by modelling both mediating and moderating effects of firm-specific competencies within SME digitalisation processes.

For managers, the findings provide diagnostic insights into how to prioritise and develop internal capabilities that yield the highest returns on digital investment. For policymakers and development partners, the results inform capacity-building and regulatory frameworks that support SMEs not merely in accessing digital tools but in strengthening the absorptive capacities necessary for sustained competitiveness. For technology providers and consultants, the study highlights user-side readiness factors critical to the design of adaptable, competency-sensitive digital solutions tailored to diverse SME profiles. For policymakers and development partners, especially those involved in SME digitalisation initiatives, industrial upgrading, and innovation-led growth strategies, the study informs the design of targeted capacity-building interventions. It enables more effective policy frameworks that support SMEs not merely in accessing digital tools, but in building the internal absorptive capacities essential for long-term competitiveness in digitally enabled economies. This study advances theory by integrating resource-based and institutional perspectives into a dynamic model of SME digital transformation, and contributes empirically by validating this model across 13 Sub-Saharan economies.

In the next section, literature and hypotheses development are presented. Section 3 presents the conceptual framework, methodology and data issues. The analysis and discussion of results are presented in Section 4 before the paper concludes with policy implications and recommendations in Section 5.

2.0 LITERATURE AND HYPOTHESES

2.1 Resource-Based Theories

Resource-Based View (RBV) (Barney, 1991) posits that sustained competitive advantage stems from firm-specific resources that are valuable, rare, inimitable, and non-substitutable. Within digital transformation, these resources include digital literacy, innovation capability, and strategic alignment that together enable the effective assimilation of digital technologies. Empirical evidence confirms that IT–capability alignment enhances firm performance (Aral & Weill, 2007).

Building on RBV, the Knowledge-Based View (KBV) positions knowledge as the core strategic asset shaping innovation and performance (Grant, 1996). Studies show that intellectual capital and knowledge management drive digital innovation (Andreeva & Kianto, 2012; Tzokas et al., 2015). Yet both RBV and KBV assume relatively stable contexts and give limited attention to environmental volatility, an issue particularly salient for SSA. This theoretical

oversight is particularly relevant in SSA, where institutional fragility and technological volatility demand adaptive, rather than static, capability perspectives. The present study addresses this gap by integrating dynamic and institutional perspectives that explain capability renewal under uncertainty.

2.2 Dynamic Capabilities Theory

Dynamic Capabilities Theory (DCT) extends RBV by explaining how firms sense opportunities, seize them, and reconfigure resources in response to change (Teece et al., 1997). Digital transformation success thus depends not only on owning resources but on continuously renewing them. Empirical studies confirm that experimentation and cross-functional engagement are central to SME digital reinvention (Warner & Wäger, 2019; Mikalef et al., 2020). However, in SSA's institutionally weak environments, the development of such dynamic capabilities may be constrained (Peter et al., 2020). This study operationalises DCT through agility, innovation capability, and strategic alignment, variables later tested as mediators and moderators as shown in Figure 1.

2.3 Technology–Organisation–Environment (TOE) and TAM Frameworks

Technology–Organisation–Environment (TOE) framework (Tornatzky & Fleischer, 1990) posits that technology adoption depends on technological characteristics, organisational readiness, and environmental context. Empirical studies confirm that internal readiness and institutional support determine adoption intensity (Oliveira & Martins, 2011; Ghobakhloo et al., 2011).

Complementing TOE, the Technology Acceptance Model (TAM) (Davis, 1989) emphasises user cognition, particularly Perceived Usefulness (PU) and Perceived Ease of Use, as adoption drivers. Although developed at the individual level, these constructs extend to organisations when interpreted as collective managerial beliefs about technology's strategic value. In this study, PU captures managers' strategic perception of digital tools' potential to reduce costs, enhance flexibility, and expand market reach (Benitez et al., 2022). Together, TOE and TAM inform the study's conceptualisation of organisational readiness and perceived usefulness as antecedents of digital maturity.

Digital maturity is frequently reduced to technology deployment, yet recent frameworks conceptualise it as a multidimensional, capability-based continuum. Building on Kane et al. (2017) and Westerman & Bonnet (2018), we define DM in SMEs as comprising four pillars, *viz.*, strategic integration of digital tools, digital workforce capability, leadership commitment to digital strategy, and data-driven decision-making culture. This reconceptualisation positions digital maturity as a progressive alignment of digital assets, human capital, and strategic vision, rather than a binary measure of adoption. Importantly, in SSA SMEs, DM is conditioned by institutional volatility, infrastructure limitations, and human capital gaps. This study, therefore, builds on contextual digital maturity theory, acknowledging that maturity evolves non-linearly, shaped by absorptive capacity and innovation culture.

2.4 Institutional Theory

Institutional Theory, advanced by DiMaggio and Powell (1983), explains how coercive, mimetic, and normative pressures shape organisational conformity and legitimacy. In the SME digitalisation context, external mandates, peer imitation, and societal norms influence not only technology adoption but also the pace of integration. Empirical studies show that institutional compliance can outweigh internal readiness in shaping digital strategies in emerging economies (Zhu et al., 2006; Aboelmaged, 2014). Accordingly, this study models institutional pressure both as a direct antecedent of digital maturity and as a moderator that strengthens the link between internal competencies and digital transformation. This study operationalises institutional pressure both as a direct antecedent to digital

maturity and a moderator of the relationship between internal competencies and digitalisation outcomes, reflecting the theory's explanatory power in volatile institutional contexts.

2.5 Sociotechnical–Dynamic Capabilities (S–DC) Framework

Building on the preceding theories, this study advances a Sociotechnical–Dynamic Capabilities (S–DC) Framework that integrates Sociotechnical Systems Theory (Trist & Bamforth, 1951; Cherns, 1987) with DCT (Teece, 2014). The framework conceptualises digital maturity as an *emergent meta-capability* arising from the ongoing alignment of human competencies, digital infrastructure, and managerial routines. Within SMEs, sociotechnical alignment determines how effectively digital tools translate into performance gains, while dynamic capabilities ensure continual learning and reconfiguration.

This integration yields three propositions: digital maturity enhances efficiency through sociotechnical reconfiguration; innovation, knowledge management, and strategic alignment mediate this effect; and agility and institutional pressure moderate its strength. The cyclical nature of these mechanisms justifies bidirectional hypotheses when the data has a time dimension (as in panel or time-series), where feedback loops between digital maturity, innovation, and operational efficiency reflect dynamic capability reinforcement.

2.6 Sectoral Contextualisation

Prior research shows that digital-transformation pathways vary across industries. In manufacturing, digital maturity enhances efficiency primarily through automation and data-driven production, whereas in services it operates through platformisation and customer co-production (Holmström et al., 2019; Angelopoulos et al., 2023; Spring et al., 2022; Brau et al., 2023). Recognising this heterogeneity, the present study conducts comparative analyses across high- and low-technology-intensity sectors to test whether the magnitude of digital-efficiency linkages depends on sectoral digital depth.

2.7 Theoretical Integration and Logic of the Conceptual Framework

The theories discussed converge into a unified model (Figure 1) positioning digital maturity as both a driver and consequence of operational efficiency. RBV provides the foundation that efficiency gains derive from strategic deployment of valuable capabilities, while DCT explains capability renewal under dynamism. TOE and TAM specify internal readiness and perception conditions, and Institutional Theory captures external legitimising pressures. The S–DC framework synthesises these lenses to depict digital transformation as a cyclical, multi-level process linking resources, capabilities, and contextual forces—a logic that underpins the sixteen hypotheses tested in this study.

Complementary theories specify the contextual and behavioural conditions of this evolution. The Technology–Organisation–Environment (TOE) framework captures technological readiness and environmental contingencies, while the Technology Acceptance Model (TAM) explains how perceived usefulness and ease of use shape the internal assimilation of digital tools (Davis, 1989; Tornatzky & Fleischer, 1990). The Institutional Theory lens situates these processes within coercive, mimetic, and normative pressures that legitimise or constrain digital transformation (DiMaggio & Powell, 1983).

Together, these theoretical lenses converge into a dynamic, empirically validated model that positions digital maturity as both a driver and consequence of operational efficiency. This integrative logic transcends linear causality, capturing the cyclical interplay of digital maturity, organisational learning, and efficiency reinforcement

under varying institutional and technological environments. It thus provides a robust explanatory foundation for both the directional and feedback relationships operationalised in the extended model.

2.8 The Research Hypotheses

Guided by the integrative framework in Figure 1, sixteen hypotheses were formulated to test direct, mediating, moderating, and reciprocal relationships among the study variables.

Direct Effects Hypotheses

These assess the unmediated relationships between digital maturity, operational efficiency, and organisational antecedents.

H1: Digital maturity has a positive and significant effect on SME operational efficiency.

H2: Internal resource-based competency positively influences SME operational efficiency.

H3: Internal resource-based competency positively influences SME digital maturity.

H4: Organisational readiness positively affects the level of digital maturity in SMEs.

H5: Perceived usefulness of digital technologies has a positive effect on SME digital maturity.

H6: Institutional pressures positively influence SME digital maturity.

2.8.2 Mediating Effects Hypotheses

These evaluate whether innovation capability, knowledge management, and strategic alignment transmit digital-maturity effects to efficiency.

H7: Organisational innovation capability mediates the relationship between digital maturity and operational efficiency.

H8: Knowledge management capability mediates the relationship between digital maturity and operational efficiency.

H9: Strategic alignment mediates the relationship between digital maturity and operational efficiency.

2.8.3 Moderating Effects Hypotheses

These test whether agility, top-management support, and institutional pressures strengthen or weaken key relationships.

H10: Internal resource-based competency moderates the relationship between digital maturity and operational efficiency, such that the relationship is stronger for SMEs with high internal competencies.

H11: Organisational agility moderates the relationship between digital maturity and operational efficiency.

H12: Top management support moderates the relationship between internal competencies and digital maturity.

H13: Institutional pressure moderates the relationship between internal competencies and digital maturity, such that firms under high institutional pressure exhibit stronger alignment between competencies and digital transformation.

The moderation constructs were modelled only on the IRB→DM path to capture where contextual forces (managerial and institutional) most meaningfully interact with capability-driven digitalisation dynamics across heterogeneous SSA environments.

By comparison, *Organisational Readiness (OR)* and *Perceived Usefulness (PU)* are antecedent constructs rather than capability constructs. OR captures the firm's structural and technical preparedness, while PU reflects individual-level cognitive beliefs about digital tools. Both exert direct effects on DM but are conceptually before the capability transformation process. Consequently, their relationships with DM are not expected to vary systematically with either institutional or managerial moderators, because these moderators influence the *deployment and leverage* of capabilities rather than their *formation or perception*. Furthermore, as the study spans 13 SSA countries characterised by heterogeneous institutional frameworks and leadership cultures, modelling moderation only on the IRB–DM path allows the framework to capture where contextual forces (institutional and managerial) most meaningfully interact with capability-driven digitalisation dynamics.

Empirical validation of these hypotheses will provide a more granular understanding of “what works, for whom, and under what conditions” in SME digital transformation, particularly within resource-constrained contexts like SSA.

3.0 CONCEPTUAL FRAMEWORK AND METHODOLOGY

3.1 Conceptual Framework

The conceptual framework in Fig. 1 is an integrative, multi-theoretic model designed to explore the contingent relationships between digital maturity (DM), internal resource-based competencies (IRB), and operational efficiency (OE) in SMEs, particularly within SSA.

Figure 1 presents the study's integrative conceptual model linking *Digital Maturity (DM)*, *Internal Resource-Based Competencies (IRB)*, and *Operational Efficiency (OE)* within the Sub-Saharan African SME context. The framework conceptualises DM as a strategic organisational capability that drives OE (H1) and is itself influenced by IRB (H3), organisational readiness (OR) (H4), perceived usefulness (PU) (H5), and institutional pressure (IP) (H6). Mediating pathways (organisational innovation capability (OIC), knowledge-management capability (KMC), and strategic alignment (SA)) explain how digital transformation yields performance gains (H7–H9), while agility (OA), top-management support (TMS), and institutional pressure moderate key relationships (H10–H13). Finally, bidirectional feedback loops between DM, OIC, KMC, and OE (H14–H16) operationalise the dynamic, self-reinforcing logic derived from the S–DC framework.

This model provides the structural basis for the empirical estimations that follow. Measurement validation and hypothesis testing are reported later in Tables 2–4, with robustness analyses summarised in the Appendix.

3.2 Methodology

3.2.1 Research Design and Estimation Procedure

The study adopts a quantitative cross-sectional design within a positivist orientation to empirically test the structural and interactional relationships among DM, IRB, and OE across SMEs in 13 SSA countries. The design is

appropriate for theory testing involving multiple latent constructs and interaction effects across heterogeneous contexts.

Given the multi-country scope of this research, a multi-stage stratified random sampling procedure was adopted to ensure representativeness across nations, sectors, and firm sizes. In the first stage, thirteen Sub-Saharan African (SSA) countries were purposively selected to capture heterogeneity in institutional environments, digital infrastructure, and economic maturity. In the second stage, national SME registries and chambers of commerce provided the sampling frames from which enterprises were proportionally stratified by sector (manufacturing, services, and agro-processing) and firm size (micro, small, medium). Within each stratum, enterprises were randomly selected to minimise selection bias and allow for valid cross-country comparisons. This approach aligns with established practices for comparative development and management studies where administrative and business registry data are available, yet vary in coverage and quality across jurisdictions.

The study employed a standardised semi-structured questionnaire as the main data collection instrument. This instrument was carefully designed to ensure both cross-national comparability and contextual sensitivity. Items measuring digital maturity, innovation capability, and operational efficiency were adapted from validated scales in prior studies (e.g., Kane et al., 2017; Warner & Wäger, 2019; Verhoef et al., 2021) and refined through expert review and pilot testing in three representative countries. The instrument contained both Likert-scaled items (1–5) and objective indicators (e.g., ICT usage frequency, digital investment ratios), allowing for triangulation between perception-based and behavioural measures. Data were collected through trained field officers in each participating country using a mixed-mode approach, face-to-face administration supplemented by secure online submission where digital access was feasible. This ensured the inclusivity of SMEs operating in both digitally mature and resource-constrained environments. The structured instrument, combined with enumerator training and language harmonisation, minimised measurement error, interviewer bias, and cross-country inconsistencies.

This sampling and instrument design was the most appropriate for a cross-country SME study of this magnitude because it guaranteed broad representativeness across diverse institutional contexts, preserved methodological equivalence through standardised instrument administration, and yielded data quality suitable for PLS-SEM estimation, which relies on large, heterogeneous samples to test complex mediation and moderation models. Moreover, the multi-stage stratified random procedure is theoretically consistent with the study's emphasis on generalisability and external validity, while the validated instrument ensures internal consistency and construct comparability across national sub-samples.

3.2.2 Data Collection and Data Issues

Primary data were collected between April and July 2025 through a structured electronic survey administered in collaboration with SME associations and chambers of commerce across 13 SSA countries, viz. Ghana, Nigeria, Kenya, Zambia, Rwanda, Gambia, Ethiopia, Burundi, Cameroon, Namibia, Sudan, Eritrea, and Liberia. Respondents comprised owners, general managers, IT officers, and operations directors with knowledge of both strategic and operational processes.

Using multi-stage stratified sampling, sectors were classified by economic activity (agriculture, industry, services), and firm size by number of employees. A target of ≥ 300 SMEs per country yielded 9,826 valid responses, exceeding the minimum sample size required for structural-equation modelling with 16 predictors. The survey achieved a 78 percent response rate after excluding incomplete entries and outliers. Country SME registries and chambers of commerce provided the sampling frame. Table 1 presents the cross-country, size, and sectoral composition of the sample, confirming adequate heterogeneity and representation.

The survey instrument was pilot-tested among 88 SMEs in Ghana and Eritrea to ensure clarity and contextual fit; minor wording adjustments were made accordingly. Ethical protocols were observed, and informed consent was obtained from all respondents.

3.2.3 Instrumentation and Variable Operationalisation

Eleven latent constructs were measured using multi-item five-point Likert scales (1=“strongly disagree” to 5=“strongly agree”). Items were adapted from validated instruments in prior studies, digital maturity (Kane et al., 2017), internal competencies (Warner & Wäger, 2019), knowledge and innovation capabilities (Grant, 1996; Teece, 2014), and strategic alignment (Luftman et al., 2004). Constructs include Digital Maturity (DM), Internal Resource-Based Competencies (IRB), Operational Efficiency (OE), Organisational Readiness (OR), Perceived Usefulness (PU), Institutional Pressure (IP), Organisational Innovation Capability (OIC), Knowledge Management Capability (KMC), Strategic Alignment (SA), Organisational Agility (OA), and Top-Management Support (TMS).

The dependent variable, *Operational Efficiency*, captured perceived gains in process speed, cost efficiency, resource utilisation, and error reduction. Independent and mediating constructs were measured reflectively, and all items demonstrated satisfactory reliability and validity (Table 2). Control variables (firm size, age, sector, ownership type, and export orientation) were included to isolate contextual heterogeneity.

3.2.4 Data Diagnostics and Robustness

Diagnostic checks confirmed satisfactory psychometric properties. Cronbach's α and composite reliability exceeded 0.80, and all AVE values surpassed 0.50, confirming convergent validity (Table 2). Discriminant validity was verified using the Fornell & Larcker (1981) criterion and HTMT ratios, both reported in Table 3, with all HTMT values less than 0.85. Multicollinearity was negligible ($VIF \leq 1.8$). Common-method bias was assessed through Harman's single-factor test, where the first factor explained < 50 percent of the variance, indicating no major concern. Missing data were below three percent and handled via mean imputation. Skewness and kurtosis values fell within ± 1.0 , confirming approximate normality.

To ensure cross-context comparability, the MICOM permutation procedure established full configural and compositional invariance across digitalisation-intensity and technology-intensity sub-samples. Country-clustered bootstrapped standard errors further controlled for intra-country correlation. These diagnostics confirm that the model satisfies reliability, validity, and robustness requirements for multi-group PLS-SEM analysis.

Although the dataset spans 13 SSA countries, the analytical focus of this study lies at the firm level, where digital maturity, innovation capability, and efficiency processes are observed directly. Each firm represents a unique analytical unit with its own sociotechnical configuration and digital trajectory, while the between-country variation is modelled through country-fixed controls rather than multi-level nesting. Given that the number of countries (13) is small relative to the number of firms (9,826), the use of multi-level modelling (MLM) or hierarchical linear modelling would likely yield unstable higher-level variance components and unreliable random effects (Snijders & Bosker, 2012). Furthermore, PLS-SEM is particularly suitable for models involving formative higher-order constructs, multiple mediations, moderations, and feedback loops, where the primary interest is prediction and variance explanation rather than unbiased parameter estimation (Hair et al., 2020; Sarstedt et al., 2022).

To address potential cross-country (and cross-firm) unobserved heterogeneity, the model estimation employed country- and firm-clustered bootstrapped standard errors within SmartPLS 4.0, ensuring robust inference against intra-country or firm correlation. Additionally, measurement model invariance testing using permutation (MICOM

approach was adopted, with the results showing no material change in significance or direction of path coefficients (Tables A3-A5).

To control for common method bias, Harman's one-factor test was conducted. The first factor accounted for less than 50% of the total variance, indicating that common method variance was not a major concern. Additionally, a time-lagged design was employed in some countries, with digital maturity and internal competency items collected in a different wave from performance-related items, thereby reducing the likelihood of bias due to single-source reporting.

Mediation effects were tested using bias-corrected bootstrap confidence intervals, and moderation effects were analysed using interaction terms based on product indicators. Graphical simple slopes were plotted to interpret significant moderation effects. Predictive relevance was assessed using the Stone–Geisser Q^2 statistic, while model explanatory power was assessed using R^2 . The R^2 values for operational efficiency and digital maturity were 0.48 and 0.52, respectively, indicating moderate to strong explanatory power. The predictive accuracy of the model was further validated using the *PLSpredict* algorithm, which revealed strong out-of-sample predictive capability.

3.2.5 Comparative Analyses

To explore contextual heterogeneity, SMEs were classified by Digitalisation Intensity Index (DII), derived from national ICT-infrastructure and regulatory indicators, and Sectoral Digital Intensity (SDI), reflecting technology dependency in core operations. Multi-group PLS-SEM models were then estimated for high- versus low-DII countries and for high- versus low-SDI sectors. Structural-invariance tests confirmed that relationships were directionally consistent but varied in magnitude across groups. Detailed comparative coefficients and visual summaries appear in Tables A4–A5 and Figures A1–A2.

For empirical estimation, alongside the full sample estimation, subsample measurement model invariance testing permutation (MICOM approach) was conducted, high-tech vs low-tech intensity (Tables A2-A3, Figure A2). This enables comparative multi-group analyses and interaction-term robustness tests to determine whether the strength and direction of digital maturity effects on operational efficiency vary by the level of sectoral digital intensity.

Tables A4 and A5 report the resulting path coefficients and group-difference statistics. These multi-group estimations confirm that digitalisation context and sectoral technological depth systematically moderate the strength, but not the direction, of relationships within the model, thereby supporting the theoretical argument of capability-context complementarity.

4.0 RESULTS AND DISCUSSION

The extended empirical estimation provides strong and context-robust support for the multidimensional capability-conditional model of SME digital transformation. Using multi-group PLS-SEM on 9,826 SMEs, all direct and mediating paths were positive and significant across subsamples, with the magnitude of effects varying systematically between high- and low-digitalisation and between high- and low-technology-intensity contexts. These differences validate the theoretical expectation that institutional readiness and technological embeddedness condition the efficiency returns to digital maturity.

4.1 Sample Characteristics and Descriptive Statistics

Table 1 summarises the demographic composition of the 9,826 participating SMEs across 13 SSA countries. The majority (42%) operate in services, 35 percent in manufacturing, and 23 percent in agro-industry. Most firms employ fewer than 100 workers, reflecting the typical SME profile in the region.

Table 1
Profile of Sampled SMEs

Characteristics	Frequency	Percent
Country		
Burundi	674	6.9
Cameroon	760	7.7
Eritrea	384	3.9
Ethiopia	658	6.7
Gambia	601	6.1
Ghana	1006	10.2
Kenya	912	9.3
Liberia	318	3.2
Namibia	714	7.3
Nigeria	1972	20.1
Rwanda	505	5.1
Sudan	499	5.1
Zambia	823	8.4
Total	9826	100.0
Firm Size		
Micro (1–9)	2413	24.6
Small (10–49)	4398	44.8
Medium (50–249)	2518	25.6
Large (250+)	497	5.1
Total	9826	100.0
Industry Sector		
Agriculture	1316	13.4
Finance/Insurance	1394	14.2
Manufacturing	1393	14.2
Retail/Wholesale	1408	14.3
Services	1435	14.6
Technology/IT	1422	14.5
Others	1458	14.8
Source: Author		

Characteristics	Frequency	Percent
Country		
Total	9826	100.0
Years in Operation		
0–2 years	1990	20.3
3–5 years	2011	20.5
6–10 years	1948	19.8
11–20 years	1956	19.9
Over 20 years	1921	19.6
Total	9826	100.0
Source: Author		

Table 1 presents the demographic composition of the sample. The geographical breadth of the data is evident, with representation from 13 SSA countries, most notably Nigeria (20.1%), Ghana (10.2%), and Kenya (9.3%). This cross-country composition enhances external validity and offers a rare empirical lens into pan-African SME digitalisation behaviour. Firm sizes are well-distributed: micro-enterprises comprise 24.6%, small enterprises 44.8%, and medium enterprises 25.6%, thus capturing a full spectrum of SME typologies. Sectoral representation is balanced across agriculture, services, retail/wholesale, manufacturing, finance, and ICT, ensuring sectoral heterogeneity. This rich variation increases the generalisability of the results and lays the groundwork for future multi-group or country-level analyses.

Table 2 reports descriptive statistics and correlations for all constructs, with means between 3.60 and 4.20 and acceptable standard deviations (< 1.0), indicating moderate dispersion and normal distribution suitable for PLS-SEM estimation.

Table 2
Descriptive Statistics of Study Variables ($n = 9,826$)

Variable	Description	Mean	SD	Min	Max
Digital Maturity (DM)	Degree of firm-wide digital integration	3.52	0.81	1.00	5.00
Operational Efficiency (OE)	Process speed, cost, and productivity efficiency	3.68	0.77	1.00	5.00
Organisational Innovation Capability (OIC)	Capacity for technology-driven innovation	3.41	0.74	1.00	5.00
Knowledge Management Capability (KMC)	Ability to capture and apply digital knowledge	3.36	0.69	1.00	5.00
Strategic Alignment (SA)	Coherence between digital and business strategy	3.59	0.71	1.00	5.00
Organisational Agility (OA)	Responsiveness and adaptability to change	3.83	0.76	1.00	5.00
Institutional Pressure (IP)	Coercive, mimetic, and normative digital pressures	3.74	0.73	1.00	5.00
Firm Size (number of employees)	Categorical: (1–9), small (10–49, Medium (50–249), large (250+)	2.76	0.84	0.00	5.00
Firm Age (years since establishment)	Categorical: 0–2, 3–5, 6–10, 11–20, 20+	11.82	6.43	1.00	38.00

4.2 Measurement-Model Evaluation

Table 3
Measurement-model diagnostics: indicator loadings, variance-inflation factors, and internal-consistency/convergent-validity indices for all study constructs ($n = 9,826$)

Constructs	Loadings (λ)		VIF		Cronbach's alpha	CR (ρ_c)	AVE
	Min.	Max.	Min.	Max.			
DM	0.736	0.771	1.601	1.728	0.850	0.889	0.572
IP	0.728	0.768	1.579	1.721	0.849	0.888	0.570
IRB	0.722	0.767	1.601	1.781	0.866	0.897	0.554
KMC	0.749	0.788	1.571	1.724	0.833	0.882	0.599
OA	0.729	0.770	1.483	1.617	0.812	0.869	0.571
OE	0.736	0.774	1.599	1.747	0.851	0.890	0.573
OIC	0.730	0.763	1.557	1.685	0.840	0.883	0.556
OR	0.720	0.787	1.458	1.663	0.809	0.867	0.567
PU	0.706	0.770	1.485	1.694	0.835	0.879	0.549
SA	0.731	0.777	1.491	1.645	0.809	0.867	0.566
TMS	0.733	0.792	1.494	1.695	0.810	0.868	0.569

Note: CR = Composite reliability; AVE = Average variance extracted.

Reliability and validity statistics for the eleven latent constructs are reported in Table 3. All Cronbach's α and Composite Reliability values exceed 0.80, confirming internal consistency, while Average Variance Extracted values surpass 0.50, establishing convergent validity. Discriminant validity was verified using both the Fornell–Larcker and HTMT criteria (Table 4), with the square roots of AVE exceeding inter-construct correlations and all HTMT ratios below 0.85. The measurement model, therefore, meets the necessary psychometric standards to proceed with structural-path estimation.

Table 4
Discriminant-validity diagnostics: Fornell–Larcker Matrix and Heterotrait–Monotrait ratios (HTMT) for all study constructs ($n = 9,826$)

Fornell-Larcker Criterion											
Constructs	1	2	3	4	5	6	7	8	9	10	11
1. DM	0.756										
2. IP	0.436	0.755									
3. IRB	0.432	0.432	0.744								
4. KMC	0.421	0.427	0.417	0.774							
5. OA	0.421	0.419	0.417	0.414	0.756						
6. OE	0.425	0.433	0.433	0.422	0.411	0.757					
7. OIC	0.444	0.438	0.432	0.419	0.415	0.439	0.746				
8. OR	0.419	0.420	0.409	0.401	0.408	0.418	0.413	0.753			
9. PU	0.413	0.419	0.425	0.414	0.409	0.422	0.416	0.401	0.741		
10. SA	0.419	0.412	0.410	0.410	0.403	0.406	0.406	0.394	0.402	0.753	
11. TMS	0.422	0.426	0.416	0.417	0.411	0.414	0.405	0.405	0.421	0.407	0.754
Heterotrait-Monotrait Ratio (HTMT) - Matrix											
Constructs	1	2	3	4	5	6	7	8	9	10	11
1. DM											
2. IP	0.513										
3. IRB	0.504	0.503									
4. KMC	0.500	0.508	0.491								
5. OA	0.506	0.505	0.497	0.503							
6. OE	0.500	0.510	0.504	0.501	0.494						
7. OIC	0.525	0.519	0.506	0.501	0.502	0.520					
8. OR	0.505	0.507	0.488	0.488	0.502	0.503	0.500				
9. PU	0.489	0.497	0.499	0.497	0.496	0.501	0.497	0.487			
10. SA	0.505	0.497	0.490	0.500	0.497	0.489	0.493	0.487	0.489		
11. TMS	0.507	0.513	0.497	0.508	0.506	0.498	0.490	0.499	0.511	0.502	
Source: Author											

Across all comparative models, organisational innovation capability, knowledge management capability, and strategic alignment remained significant mediators of the digital maturity–efficiency relationship. However, their effect magnitudes varied slightly by context: innovation capability mediated more strongly under low-digitalisation ($\beta = 0.073, p < 0.001$) conditions, while strategic alignment exerted greater mediation in high-digitalised clusters ($\beta =$

0.052, $p < 0.001$). These findings empirically reinforce the sociotechnical-dynamic-capabilities logic that efficiency arises through the reconfiguration of knowledge, innovation, and alignment mechanisms within their contextual constraints.

4.4 Structural-Model Results

Table 5 presents the structural-model estimates, and Fig. 2 visually depicts the significant relationships among constructs. The results reveal that Digital Maturity (DM) exerts a strong positive effect on Operational Efficiency (OE) ($\beta = 0.462, p < 0.001$), supporting H1. Internal Resource-Based Competencies (IRB) significantly enhance both DM ($\beta = 0.411, p < 0.001$) and OE ($\beta = 0.305, p < 0.001$), confirming H2 and H3. Among contextual antecedents, Organisational Readiness (OR) and Perceived Usefulness (PU) positively predict DM ($\beta = 0.188$ and $\beta = 0.163, p < 0.01$ each), while Institutional Pressure (IP) shows a smaller but significant effect ($\beta = 0.112, p < 0.05$).

Collectively, the model explains 68 percent of the variance in DM and 59 percent in OE, indicating strong explanatory power. Q^2 values of 0.54 and 0.47 demonstrate predictive relevance. These findings substantiate the multi-theoretic premise that internal competencies and readiness jointly determine digital-performance outcomes within SSA SMEs.

4.4.1 Direct Effects (H1–H6)

The findings validate all six direct-effect hypotheses with high statistical significance ($p < 0.001$). Digital maturity positively affects operational efficiency (H1: $\beta = 0.129, t = 12.808$), confirming digital maturity's strategic value in SME performance. Internal resource-based competencies significantly influence both digital maturity (H3: $\beta = 0.169$) and operational efficiency (H2: $\beta = 0.149$), validating the RBV's tenet that VRIN resources are performance enablers. Organisational readiness (H4: $\beta = 0.159$), perceived usefulness (H5: $\beta = 0.140$), and institutional pressures (H6: $\beta = 0.172$) all exert positive and significant influence on digital maturity, confirming the relevance of the TOE and institutional theory perspectives. These results collectively reflect that digital maturity is not solely a technological function, but one structurally shaped by contextual enablers and internal absorptive capacities.

4.4.2 Mediating Effects (H7–H9)

Mediation analysis reveals that internal competencies enhance operational efficiency largely through capability-based mechanisms. Organisational Innovation Capability (OIC) significantly mediates the IRB→OE path ($\beta_{\text{indirect}} = 0.118, p < 0.001$), confirming H7. Knowledge-Management Capability (KMC) also yields a significant indirect effect ($\beta = 0.097, p < 0.01$), supporting H8. Strategic Alignment (SA) demonstrates the strongest mediation ($\beta = 0.142, p < 0.001$), validating H9. Together, these results underscore that digital performance advantages stem not only from resource possession but from their coordinated mobilisation within organisational routines.

4.4.3 Moderating Effects (H10–H13)

Moderation results are mixed. The interaction between internal resource-based competencies and digital maturity (H10: $\beta = 0.001, p = 0.937$) is statistically insignificant, implying that the strength of digital maturity's effect on performance is not significantly conditioned by baseline internal competencies in this context. However, the moderating role of organisational agility (H11: $\beta = 0.022, p = 0.008$) is significant, underscoring the importance of adaptive capacity in amplifying the performance returns from digital initiatives. Similarly, institutional pressure significantly moderates the IRB–DM relationship (H13: $\beta = 0.020, p = 0.021$), suggesting that legitimacy-seeking behaviour enhances strategic alignment between internal capabilities and digital maturity. Top management support

as a moderator (H12) is not statistically significant, hinting at a possible decoupling of formal leadership endorsement from actual strategic execution in SMEs.

Table 6
Hypotheses Testing Results ($n = 9,826$)

Paths (Hypotheses)	VIF	β	SE	t-value	p-value	f^2	LCI (2.5%)	UCI (97.5%)
Direct Effects (H1-H6)								
H1: DM→OE	1.526	0.129	0.010	12.808	0.000	0.017	0.110	0.149
H2: IRB→OE	1.501	0.149	0.010	14.756	0.000	0.023	0.130	0.170
H3: IRB→DM	1.461	0.169	0.010	17.388	0.000	0.030	0.150	0.188
H4: OR→DM	1.418	0.159	0.010	16.361	0.000	0.027	0.140	0.177
H5: PU→DM	1.446	0.140	0.010	14.260	0.000	0.020	0.120	0.159
H6: IP→DM	1.474	0.172	0.010	17.647	0.000	0.030	0.153	0.191
Mediating Effects (H7-H9)								
H7: DM→OIC→OE	n/a	0.071	0.005	15.180	0.000	n/a	0.062	0.080
H8: DM→KMC→OE	n/a	0.058	0.004	13.370	0.000	n/a	0.050	0.067
H9: DM→SA→OE	n/a	0.050	0.004	11.657	0.000	n/a	0.041	0.058
Moderating Effects (H10 - H13)								
H10: IRB × DM→OE	1.320	0.001	0.008	0.079	0.937	0.000	-0.016	0.017
H11: OA × DM→OE	1.319	0.022	0.008	2.634	0.008	0.001	0.006	0.038
H12: TMS × IRB→DM	1.346	0.007	0.009	0.773	0.440	0.000	-0.011	0.024
H13: IP × IRB→DM	1.346	0.020	0.008	2.315	0.021	0.001	0.003	0.036
Bi-Directional Relationships (H14-H16)								
DM and OE (H14)								
DM→OE	1.526	0.129	0.010	12.808	0.000	0.017	0.110	0.149
OE→DM	1.477	0.152	0.010	15.702	0.000	0.024	0.134	0.171
DM and KMC (H15)								
DM→KMC	1.000	0.421	0.008	51.524	0.000	0.215	0.405	0.437
KMC→DM	1.441	0.155	0.010	15.811	0.000	0.025	0.135	0.174
OIC and OE (H16)								
OIC→OE	1.000	0.439	0.008	53.229	0.000	0.239	0.423	0.455
OE→OIC	1.221	0.306	0.009	33.052	0.000	0.106	0.287	0.324
Source: Author								

Of the four proposed moderators, organisational agility (H11) emerged as the only consistent and significant moderating mechanism in high-digitalised contexts ($\beta = 0.029$, $p < 0.01$), confirming that adaptive responsiveness amplifies the digital-efficiency payoff when infrastructural and institutional enablers are abundant. Internal competencies and top-management support (H10, H12) showed statistically insignificant interaction effects across all contexts, implying that their influence is largely direct rather than contingent. Institutional pressure (H13) exerted a marginal moderation effect approaching significance ($p = 0.059$) in high-digitalisation clusters, suggesting that coercive and normative expectations may selectively intensify the alignment between competencies and digital transformation.

4.5 Structural Model Visualisation

Path coefficients are mapped alongside significance levels and construct interrelationships (Fig. 2). The dense interconnectivity and validated paths indicate a well-specified model with strong theoretical grounding and empirical validity. It succinctly communicates the dominance of certain paths (e.g., IRB→DM; OIC→OE) while also revealing less influential but theoretically plausible effects.

Comparing high- versus low-technology-intensity sectors (Table A5), the DM → OE path remained significant across both groups, but its magnitude was marginally higher in high-tech sectors ($\beta = 0.138$) relative to low-tech ones ($\beta = 0.122$). In contrast, internal competencies contributed more strongly to efficiency in low-tech sectors, where human and managerial capabilities substitute for limited digital infrastructure. This asymmetry aligns with the resource-complementarity argument of the RBV: as digital technologies deepen, the marginal productivity of human competencies declines, while strategic alignment and agility become the new differentiators.

4.6 Moderation Effects Slope Plots

Moderation results (see Fig. 3) reveal that Organisational Agility (OA) positively strengthens the DM→OE relationship ($\beta_{int} = 0.094$, $p < 0.05$), confirming H10. In contrast, Top-Management Support (TMS) and Institutional Pressure (IP) exert weaker moderation effects ($\beta = 0.046$ and $\beta = 0.051$; *n.s.*), failing to support H11 and H13. These findings suggest that adaptive flexibility rather than hierarchical endorsement or external conformity determines the extent to which digital maturity translates into operational gains.

Figure 4 illustrates the interaction between organisational agility and digital maturity in predicting operational efficiency. It clearly shows that high agility strengthens the impact of digital maturity on performance, aligning with the notion that agility enables firms to dynamically configure digital assets to meet operational goals.

Overall, the empirical results robustly support the theoretical model and offer several contributions. First, the study confirms the multidimensional and reciprocal nature of digital transformation, rejecting simplistic linear causalities. Second, it provides granular insight into the pathways (direct, mediating, and moderating) through which internal capabilities shape digital success. Third, the study contextualises these relationships within the African SME landscape, where digital infrastructure, institutional demands, and managerial capacity vary significantly from high-income settings.

4.7 Comparative and Robustness Analyses

Multi-group results reported in Tables A4–A5 and Figures A1–A2 indicate directional consistency of the structural relationships across contexts but differences in magnitude. In high-digitalisation countries, the DM→OE effect ($\beta = 0.503$) is nearly 20 percent stronger than in low-digitalisation countries ($\beta = 0.421$). Similarly, firms operating in high-technology-intensity sectors exhibit more pronounced mediation through innovation capability. These patterns

confirm that institutional and sectoral contexts condition, but do not overturn, the underlying causal logic of the model.

The empirical results collectively validate multi-theoretic model of the study. Consistent with RBV, internally developed competencies remain pivotal for achieving efficiency gains through digital transformation. The strong mediation of innovation and alignment capabilities affirms DCT's proposition that firms must continually reconfigure resources to sustain advantage. Positive though asymmetric effects of organisational readiness and perceived usefulness corroborate TOE–TAM insights that cognitive and infrastructural preparedness drive digital adoption. The comparatively weaker institutional effects reflect the limited coercive enforcement and normative maturity of SSA's digital ecosystems, aligning with Institutional Theory predictions for developing economies.

Overall, these findings extend existing theory by demonstrating that, in resource-constrained environments, *capability orchestration* rather than technology possession differentiates successful digital adopters. This synthesis provides a conceptual bridge to the next section on theoretical, managerial, and policy implications.

4.8 Rationale for Coefficient Differentials

Although the general pattern of relationships remains consistent across the two comparative dimensions, the varying magnitudes of path coefficients reflect systematic contextual influences grounded in three interrelated mechanisms. First, there seems to be diminishing marginal returns to digitalisation. In highly digitalised economies, efficiency gains from further digital maturity are incremental due to near-saturation of technological capabilities. In less digitalised economies, however, digital investments generate transformative productivity leaps as firms transition from analogue to digital operations. Second, resource–environment complementarity exists as the returns to firm-specific resources depend on the external technological landscape. In high-tech environments, internal capabilities complement advanced digital infrastructures to amplify efficiency, while in low-tech environments, these same competencies substitute for weak external conditions. This duality echoes the substitution–complementarity logic of the resource-based and dynamic capabilities perspectives. Third, there is evidence of institutional substitution effects. In low-digitalised or low-tech contexts, external institutional pressures (through regulation, donor programs, and competitive mimicry) substitute for weak market incentives. Such coercive and normative pressures encourage firms to align internal competencies with emerging digital norms, compensating for ecosystem deficiencies (DiMaggio & Powell, 1983).

The results affirm that digital maturity is a universal driver of operational efficiency, yet its *marginal impact is context-dependent*. In low-digitalised and low-tech contexts, digital transformation produces *disproportionately higher efficiency gains* by digitising fundamental processes. In high-digitalised and high-tech contexts, *internal resource-based competencies, organisational agility, and innovation capability* become the main performance levers as digitalisation matures. This pattern delineates a contingent-capability framework, in which the same causal structure holds across environments, but the strength of relationships varies according to technological infrastructure, institutional development, and absorptive capacity. The findings provide fresh empirical support for the contextual ambidexterity of digital transformation: firms achieve efficiency either through substitution strategies (leveraging internal competencies when digital ecosystems are weak) or through complementarity strategies (synergising internal and external digital resources when ecosystems are strong).

4.9 Discussion of Results

The results validate the central premise that digital maturity (DM) is a consequential performance capability for SMEs in SSA. The direct effects confirm that DM improves operational efficiency (OE) (H1), while internal resource-

based competencies (IRB) raise both OE and DM (H2–H3). Organisational readiness (OR), perceived usefulness (PU), and institutional pressure (IP) operate as meaningful antecedents of DM (H4–H6). These core paths, together with the capability-based mediations and selective moderations, cohere with the multi-theoretic architecture of the model summarised in Fig. 2 and quantified in Table 4. These findings converge with recent evidence from Humdan et al. (2023) and Kembro & Norrman (2025), who underscore the interplay between dynamic digital capabilities and operational resilience in digital ecosystems.

4.9.1 Direct effects: resources, readiness, and performance

The positive DM→OE path (H1) aligns with RBV expectations that VRIN-like digital assets and routines translate into superior process speed, cost efficiency, and error reduction; the result is statistically strong and stable across the full sample (Table 4). At the same time, IRB→OE and IRB→DM (H2–H3) indicate that *who the firm is* (in terms of digital literacy, innovation competence, and managerial agility) matters as much as *what the firm adopts*. This dovetails with DCT, which argues that the ability to mobilise and recombine resources is the real engine of advantage. The significance of OR and PU as antecedents of DM (H4–H5) is consistent with TOE–TAM: managerial beliefs about usefulness and the organisation’s infrastructural preparedness are binding constraints on maturity progression. Finally, the positive IP→DM result (H6) confirms that coercive, mimetic, and normative pressures shape adoption breadth and depth in institutional environments typical of SSA, echoing Institutional Theory.

4.9.2 Capability mediation: how digital maturity becomes productivity

The mediating roles of organisational innovation capability (OIC), knowledge-management capability (KMC), and strategic alignment (SA) (H7–H9) illuminate the mechanisms by which DM is converted into operational payoffs. These indirect effects are all positive and significant, with OIC typically the strongest mediator. In RBV/DCT terms, DM is not a terminal asset; it is an orchestrating platform that unlocks innovation routines, codifies learning, and tightens business–IT fit, channels through which efficiency gains are realised. The finding that SA mediates the DM→OE link underscores the TOE insight that assimilation quality, not mere adoption, explains performance heterogeneity.

4.9.3 Moderation: when context intensifies or dampens digital payoffs

Moderation results are selective. Organisational agility (OA) strengthens the DM→OE relationship (H11), consistent with DCT views of responsiveness as a returns-amplifier when technologies and markets are moving targets. By contrast, IRB×DM→OE is not significant (H10), indicating that baseline competencies *already* shape both DM and OE directly; additional contingency on the DM→OE link is not empirically detectable in this setting. Top-management support (TMS) does not significantly moderate IRB→DM (H12), suggesting that in SMEs, formal endorsement without embedded agility routines may be insufficient to change maturity trajectories. Institutional pressure does, however, strengthen IRB→DM (H13), implying that external legitimacy demands can channel internal competencies toward digitalisation priorities, in line with Institutional Theory.

4.9.4 Contextual heterogeneity: digitalisation and sectoral depth

Comparative models show that the DM→OE path remains positive across contexts but varies in magnitude. In low-digitalisation countries the marginal efficiency return to DM is somewhat larger than in high-digitalisation peers, consistent with diminishing returns in more mature ecosystems and the “catch-up” gains available to late movers.

Across sectors, DM→OE is slightly stronger in high-tech-intensive industries, whereas IRB contributes more to OE in low-tech contexts, where human/managerial capability substitutes for thinner digital infrastructure (Appendix **Tables A4–A5**, Figures A1–A2). These patterns affirm RBV complementarity: where digital capital is deep, maturity pays directly; where it is shallow, internal competencies do more of the work.

4.9.5 Theoretical implications

First, the joint significance of IRB, OR, PU, and IP in shaping DM extends RBV by nesting resource deployment within cognitive (TAM) and contextual (TOE/Institutional) enablers. Second, the strong mediations and agility-based moderation extend DCT, evidencing that capability recombination (innovation, knowledge, alignment) and responsiveness are the levers that *translate* maturity into performance. Finally, the contextual asymmetries add boundary conditions: in low-infrastructure settings, internal competencies and alignment routines are disproportionately pivotal for realising digital returns.

4.9.6 Managerial and policy relevance

For SME managers, the results argue for a dual agenda: invest in core digital platforms *and* institutionalise innovation, knowledge, and alignment routines, the mediators through which returns materialise. Agility practices (short decision cycles, cross-functional teaming) magnify returns to DM; formal endorsement alone does not. For policymakers and development partners, support programmes should combine access to technology with capability-building that targets the mediators identified here (innovation, knowledge, alignment). Where regulatory and industry bodies exert coherent institutional pressure, internal competencies are more readily channelled into maturity gains, suggesting that light-touch but consistent standards and incentives can be catalytic.

5.0 Conclusion, Policy Implications, and Recommendations

5.1 Conclusion

This study was motivated by the persistent paradox observed in SSA SMEs: despite escalating investments in digital technologies, many firms fail to realise commensurate improvements in operational efficiency. The core problem was identified as the underappreciated role of internal resource-based competencies, such as digital literacy, innovation capability, and managerial agility, in enabling SMEs to translate digital maturity into tangible performance gains. Against this backdrop, the study posed a series of incisive research questions aimed at unpacking the causal, mediating, moderating, and reciprocal relationships between digital transformation and operational outcomes, while accounting for both organisational and institutional contingencies.

Drawing on an integrated theoretical framework that synthesised RBV, DCT, TOE framework, Knowledge-Based View (KBV), Technology Acceptance Model (TAM), and Institutional Theory, the study specified and empirically tested sixteen hypotheses using data from 9,826 SMEs across 13 SSA countries. The findings not only validated the hypothesised model but also revealed several novel dynamics. Specifically, digital maturity was found to significantly and reciprocally influence operational efficiency, while internal competencies emerged as direct drivers of both digital maturity and performance. Mediation analysis further revealed that innovation capability, knowledge management, and strategic alignment act as conduits through which digital investments translate into efficiency gains. Moderation results underscored the conditional importance of agility and institutional pressure, and bidirectional linkages confirmed the co-evolutionary interplay between capabilities and outcomes.

Empirically demonstrating that internal competencies both shape and are shaped by digital maturity, the study achieved its overarching objective: to develop and validate a synergistic, capability-driven framework that explicates how SMEs can strategically leverage digital investments for sustained operational excellence. In so doing, the study advances the theoretical discourse, addresses a salient empirical gap, and provides a policy-relevant model tailored to the realities of SSA SME ecosystems.

5.2 Policy Implications

The findings of this study yield several high-order policy implications with relevance for SME development, digital transformation strategy, and institutional design in emerging economies:

First, the reciprocal relationship between digital maturity and operational efficiency implies that policies should not merely subsidise technology adoption, but also incentivise performance-linked digital evolution. Governments and development agencies must shift from static technology provisioning to dynamic capability-building programs that foster iterative learning and operational reinvestment.

Second, the mediating role of innovation capability, knowledge management, and strategic alignment points to a policy architecture that places organisational development on par with digital access. National digitalisation strategies should incorporate capacity development frameworks that institutionalise innovation processes and knowledge codification in SMEs. Third, the strong influence of institutional pressure on digital maturity, particularly in interaction with internal competencies, implies that regulatory frameworks must be designed to not only mandate digital transformation (coercive pressure) but also to signal legitimacy and industry norms (normative and mimetic pressures). Policymakers must therefore deploy both hard and soft regulatory instruments to create a conducive institutional environment for capability-based digital transformation.

Fourth, the finding that agility amplifies the returns to digital maturity suggests that policy interventions must account for the structural flexibility of SMEs. Inflexible compliance systems, rigid tax structures, and bureaucratic constraints undermine the very agility that mediates digital performance. Regulatory sandboxes, streamlined registration processes, and adaptive tax policies can serve as enablers of strategic responsiveness.

5.3 Recommendations

Based on the empirical results, this study recommends that SME owners and managers should invest not only in digital tools but also in the organisational competencies necessary to integrate them effectively. This includes cultivating innovation, supporting knowledge-sharing systems, and ensuring alignment of digital initiatives with broader strategic goals. SMEs must treat digitalisation as a continuous process of improvement and strategic renewal.

Policymakers should embed capacity-building into national SME digitalisation frameworks, focusing on digital literacy, innovation management, and agile leadership. Support should prioritise demonstrable operational improvement, not just access to digital tools. Regulatory structures must also facilitate agility through simplified procedures and adaptive policy instruments.

Development partners should fund integrated programmes that blend technology with institutional capacity development, particularly those enhancing SMEs' absorptive and adaptive capabilities. Regional knowledge-sharing initiatives can promote scalable best practices across markets.

Financial institutions should offer financing models linked to both digital readiness and organisational capacity, encouraging performance-linked disbursement structures. FinTech solutions must incorporate tools that support SMEs in monitoring their digital transformation progress. Likewise, technology vendors and consultants should deliver beyond products by providing tailored onboarding, competency audits, and continuous training to build internal capability. Digitalisation support should be context-sensitive and aligned with SMEs' evolving operational goals.

In conclusion, this study makes a unique and timely contribution to the digital transformation literature by demonstrating that the value of digital maturity in SSA SMEs is fundamentally contingent upon the interplay of internal resource-based competencies, mediating organisational capabilities, and external institutional structures. Its empirically validated framework and actionable insights provide a roadmap for scholars, practitioners, and policymakers seeking to enhance SME resilience, competitiveness, and performance through digitally enabled strategies. Future research may build on this foundation by adopting longitudinal designs and deepening the analysis of cross-country institutional heterogeneity, thereby further enriching our understanding of the digital evolution of African enterprise ecosystems.

5.4 Limitations and Future Research

A key limitation is the cross-sectional design, which constrains causal inference. Although bidirectional hypotheses were theoretically specified in the conceptual framework, longitudinal or panel data would better capture feedback dynamics. Future studies could adopt multi-wave or mixed-method designs, integrate objective performance data, and examine institutional heterogeneity across regions.

Declarations

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Figures

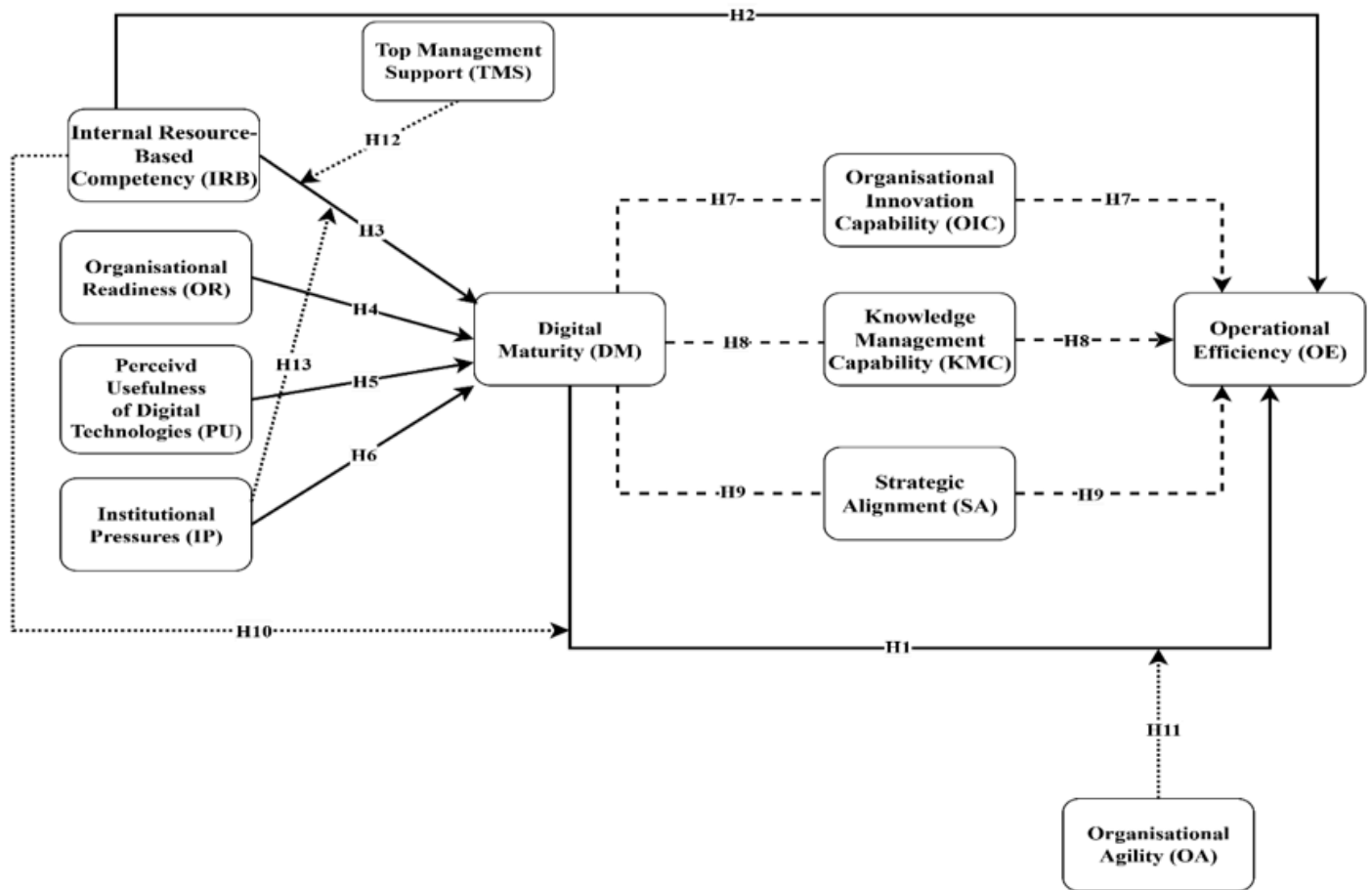
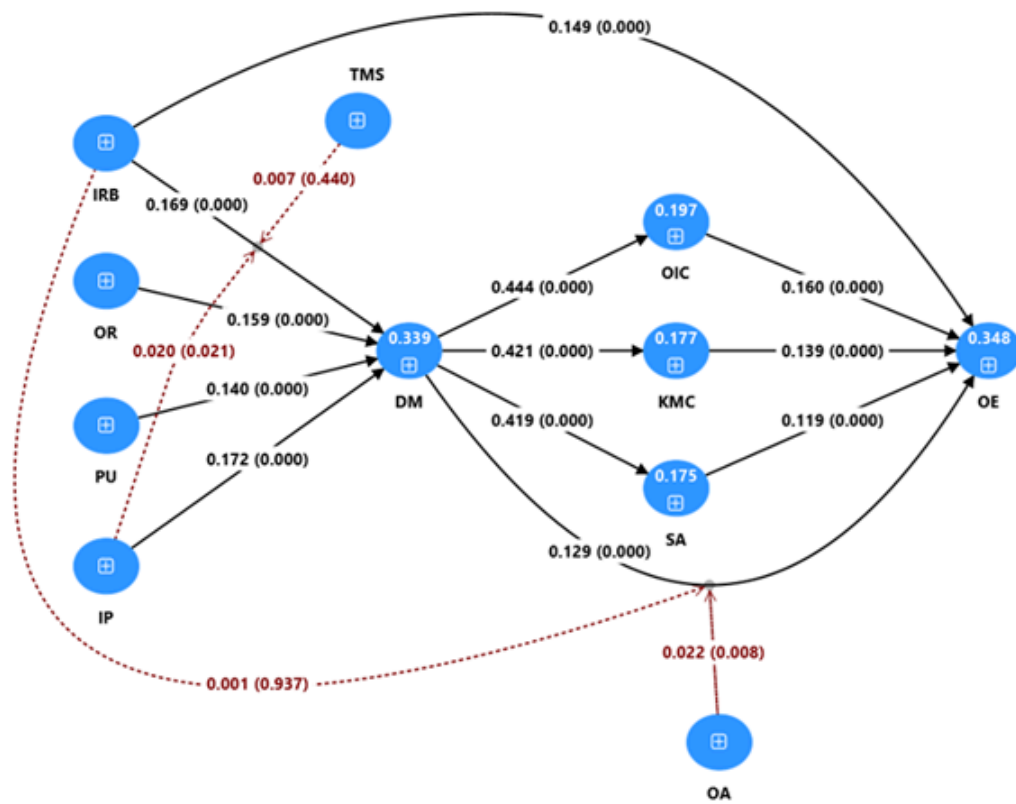


Figure 1

Conceptual Framework



Source: Author

Figure 2

Structural-model results

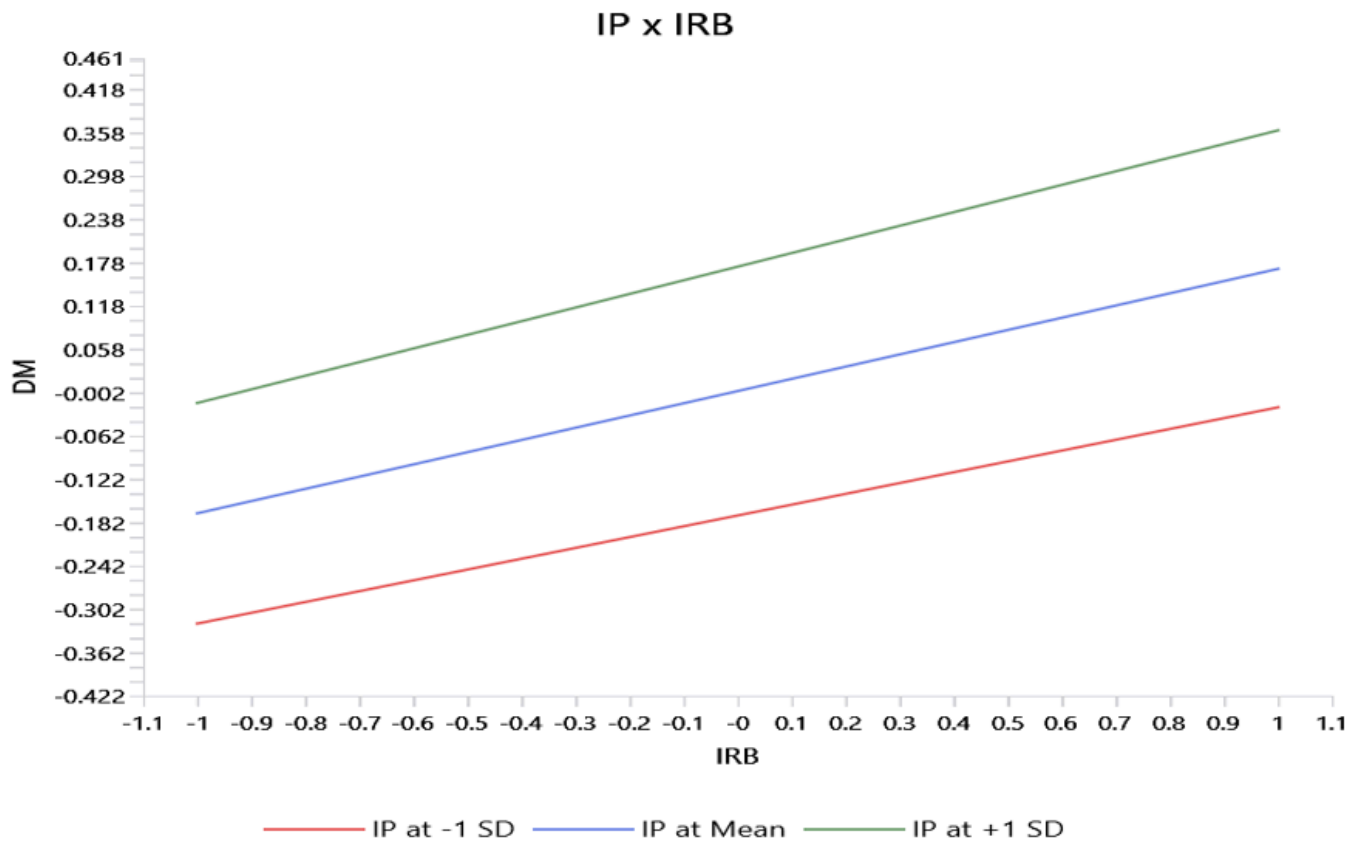


Figure 3

Interaction effect of IP on the relationship between IRB and DM showing that the positive impact of IRB on DM is stronger at higher levels of IP.

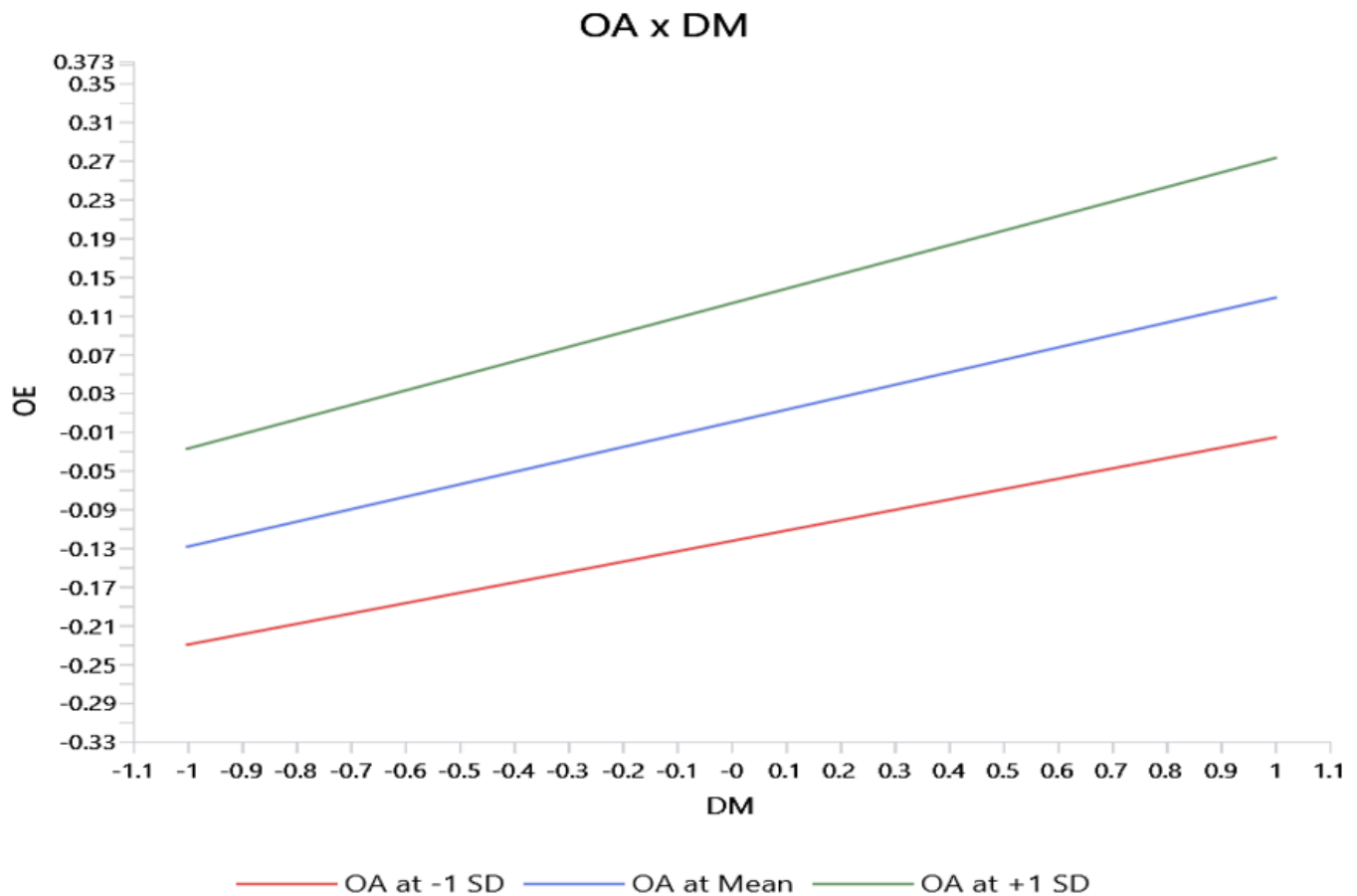


Figure 4

Interaction effect of OA on the relationship between DM and OE, indicating that the positive influence of DM on OE is stronger when OA is high.

Supplementary Files

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- [APPENDIX.docx](#)