

# **A Literature-Based Strategy Framework to Bridge the AI Skills Gap in South African SMMEs and Improve Operational Efficiency**

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## **Abstract**

Small, Medium, and Micro Enterprises (SMMEs) are pivotal players in economies worldwide, especially in developing and emerging economies, where they contribute significantly to job creation, poverty alleviation, and innovation. Despite their limited capital and financial resources. Key findings indicate that AI has evolved from emerging technology to an essential component of business decision-making, enabling companies to navigate complex environments effectively. Studies show that even though while AI is driving efficiencies, unlocking innovation, and creating new opportunities across various industries in South Africa, from banking and retail to mining and the public sector, the country faces a critical challenge: a severe shortage of AI-related skills. This skills gap is not merely a buzzword; it is a systemic challenge that threatens South Africa's competitiveness, risks widening inequality, and leaves millions of workers unprepared for the future. Industries undergoing rapid digital transformation are facing a significant global challenge: a widening gap between required and available workforce digital skills. This study will employ a literature review methodology, relying exclusively on peer-reviewed articles, industry reports, and policy documents. This study aims to identify key determinants of this gap and develop a comprehensive conceptual framework for mitigation.

## **Keywords**

AI skills gap, Artificial Intelligence, Operational efficiency, SMMEs and Adoption barriers

## **1. Introduction**

Small, medium, and micro-enterprises (SMMEs) are key to global economies, especially in developing markets. They generate employment, reduce poverty, and drive innovation despite limited capital and resources. SMMEs support new product development, technological progress, industrial renewal, and economic growth (Sibiya et al., 2023). They also promote diversification in emerging sectors to address underdevelopment. In South Africa, SMMEs make up 91% of formal businesses, employ about 60% of the workforce, and contribute roughly 34% to GDP (Stević et al., 2020). Amid rapid technological change, artificial intelligence is reshaping business (Vásquez, 2025). Research shows

AI influences decision-making by integrating into management, improving performance evaluation, and boosting business engagement. Studies highlight AI's challenges and opportunities, tracing its shift from emerging tools to core strategic elements that help firms manage complex operations. AI integration offers strong potential for growth and sustainability (Kumar & Shrivastava, 2025). Firms worldwide use AI to streamline operations, enhance decisions, and create growth opportunities from task automation to strategic analytics. AI has become central to modern organizations, enabling better customer engagement, resource use, and profits (Kumar & Shrivastava, 2025). In South Africa, AI enhances efficiency, fosters innovation, and creates new opportunities across sectors such as banking, retail, mining, and public services; however, the country faces a severe shortage of AI skills (Pillai, 2025). Far from mere hype, this skills gap constitutes a systemic crisis that threatens national competitiveness, widens socioeconomic inequalities, and leaves much of the workforce unprepared for future demands. Globally, sectors undergoing rapid digital transformation face an imbalance with a growing mismatch between required and existing digital competencies. This study identifies the primary causes of this disparity and proposes an integrated framework to address it, focusing on technological advancement, human capital, and organizational resilience in South African SMMEs to bridge the AI skills deficit. This deficit critically impedes SMME's capacity for innovation and adaptation to dynamic market demands, thereby compromising their operational efficiency and long-term viability, particularly within resource-constrained environments (Madondo et al., 2024; Nwagbala et al., 2025). This challenge is worsened by financial constraints and a shortage of specialized expertise within SMMEs, conflicting with larger corporations that possess the resources for seamless AI integration (Holland, 2026). The framework targets SMME challenges in resource-limited settings, including limited finance and technology access, poor infrastructure, and the need for change management to adopt AI (Nwagbala et al., 2025; Okoye et al., 2024; Weilbach, 2025). Such a framework would prioritize developing internal capabilities within these entities to not only enhance their performance but also ensure long-term sustainability by integrating existing business functions (Zhou et al., 2024).

### **1.1 Objectives**

The primary objective of this study is to analyse the critical barriers to AI adoption among South African SMMEs, particularly in the context of skill shortages and infrastructure limitations (Weilbach, 2025). Specifically, it aims to identify the specific AI competencies lacking within the SMME workforce and to propose targeted interventions, including educational and policy-based solutions, to bridge this critical gap (Twabu, 2025). Furthermore, this research will evaluate the efficacy of current governmental and private sector initiatives aimed at fostering AI proficiency and technological integration within the SMME ecosystem, offering recommendations for enhancement (Sheik, 2023; Závodná et al., 2024). This will involve a comprehensive assessment of existing AI frameworks tailored for multi-tenant architectures to deliver scalable solutions to SMMEs with varying needs (Par, 2025). This will be achieved by:

- Compiling and synthesising academic literature on AI skill shortages, obstacles to SMME AI adoption, and their impacts on operational performance.
- Develop a tailored strategic model for SMMEs operating in resource-limited settings.
- Outline the pathway from skills development to AI integration and improved operational efficiency, drawing on the Technology-Organization-Environment, Diffusion of Innovations, and Technology Acceptance Model frameworks. This integrated approach will assess how these frameworks can inform practical strategies for implementing AI solutions in SMMEs, especially in contexts characterized by limited infrastructure and financial constraints (Weilbach, 2025).

### **2. Methods**

This study adopts a literature review methodology, relying exclusively on peer-reviewed articles, industry reports, and policy documents, without primary data collection or fieldwork. Relevant sources were identified through systematic keyword searches ("AI skills gap," "digital skills," "SMMEs," "operational efficiency" and "AI adoption") in databases including Google Scholar, Scopus, EBSCOhost, and ScienceDirect, supplemented by platforms such as the World Economic Forum, OECD, and South African government publications on digital transformation. Literature selection for studies on " Frameworks to bridge the AI skills gap in South African SMMEs " adhered to rigorous inclusion and exclusion criteria, prioritizing recency of publication, peer-reviewed status, and alignment with core search terms to ensure relevance and scholarly quality. A thematic analysis revealed the following four themes: essential AI skills for SMMEs, barriers to AI readiness, training and support mechanisms, and the link between AI skills and operational efficiency. This approach ensures the strategic framework is firmly grounded in credible evidence, informing tailored recommendations to bridge skills gaps and enable AI integration in the SMME sector. This comprehensive

methodology underpins the development of a robust framework designed to enhance the competitive advantage and foster innovation within SMMEs through strategic AI adoption.

### **3. Literature Review**

Due to AI's rapid evolution, this review emphasizes recent studies to highlight current advancements and challenges (Prazeres & Pina, 2024). It examines the theoretical foundations of AI adoption in SMMEs, assessing models and frameworks for applicability in South Africa. The section also evaluates AI's socio-economic impacts, including workforce displacement and the need for adaptive skills in formal and informal sectors. It addresses SMME challenges such as limited capital access, poor digital infrastructure, and regulatory issues. Finally, it explores how South Africa's historical and socio-political context worsens the digital divide and hinders inclusive growth. This comprehensive approach aims to elucidate the multifaceted barriers to AI integration and skill development, providing a robust foundation for the proposed framework. This investigation will systematically review existing literature on AI applications, focusing on their practical implications for enhancing business operations, decision-making processes, and market competitiveness within the SMME sector.

#### **3.1 Overview of AI Skills Gap among South African SMMEs**

It is anticipated that by 2035, organizations using AI will achieve 40% higher operational efficiency than today (Akoh, 2024). South African small, medium, and micro enterprises must therefore prioritise AI adoption to drive growth and global competitiveness. AI has drawn significant academic and practical interest in the SMME sector for improving efficiency, decision-making, and sustainability (Chasaya & Ayandibu, 2025). Yet, South African SMMEs adopt AI slowly due to low organisational readiness and skills shortages, which undermine their competitiveness. Although AI offers many benefits, it requires substantial resources, restructuring, and advanced infrastructure, making adoption urgent (Akoh, 2024). Delays risk widening skills gaps, leaving late adopters behind those advancing through digital strategies and better performance. Research and targeted interventions are thus essential to enable AI adoption in SMMEs. This study proposes a framework to bridge the AI skills gap in South African SMMEs (Akoh, 2024). The framework provides a clear path to build AI competencies technical and strategic in resource-constrained settings. It analyzes factors shaping AI adoption and skills development, with tailored strategies for capacity building and sustainable integration (Osasona et al., 2024). This involves overcoming significant hurdles, such as inadequate digital infrastructure, limited financial resources, and the absence of contextually appropriate regulatory frameworks (Mweha, 2026).

#### **3.2. Barriers to AI adoption in SMMEs**

Although artificial intelligence offers substantial potential to transform marketing practices across Africa, its adoption faces significant barriers, including infrastructure deficits, cultural factors, and regulatory hurdles (Alice & Ebuka, 2024). These challenges hinder effective AI integration in businesses continent-wide. In South Africa, SMMEs encounter specific obstacles such as poor system integration, limited technical expertise, high development costs, and inadequate infrastructure (Wilma & Booshnam, 2025). Additional issues include high costs for implementation and maintenance, as well as data quality and access problems (Par, 2025). Weak digital infrastructure and a shortage of AI-skilled personnel further intensify these barriers for resource-constrained SMMEs (Enshassi et al., 2023; Shibiti et al., 2023). A key impediment is the AI skills gap, marked by insufficient trained staff to deploy and manage AI applications (Proietti & Magnani, 2025). This gap also involves limited strategic awareness of AI's business applications and benefits (Hussain & Rizwan, 2024).

#### **Limited Digital Infrastructure**

A key barrier to AI adoption in marketing across Africa is the lack of robust digital infrastructure. Many areas, especially rural ones, face challenges with internet connectivity, reliable electricity, and access to digital devices. AI technologies require stable, high-speed internet to function effectively, particularly for cloud computing, data analytics, and real-time processing. Poor infrastructure limits businesses' ability to use AI for customer engagement, predictive analytics, and personalized marketing. In many African countries, internet penetration remains low, worsened by unreliable power supply. Without a strong digital foundation, even urban businesses struggle to deploy AI solutions, facing issues with data storage, processing speed, and access to cloud-based AI tools (Alice & Ebuka, 2024). This infrastructure gap hinders the scalability and reliability needed for advanced AI operations (Kedi et al., 2024). Furthermore, the absence of widespread digital literacy and specialized AI expertise within the workforce worsens these infrastructural limitations, creating a dual challenge for SMMEs aiming to integrate AI into their marketing strategies (Enshassi et al., 2023; Yusuf et al., 2024). For example, the lack of adequate ICT infrastructure,

including low internet penetration rates and limited access to high-performance computing, significantly impedes the adoption and implementation of AI systems (Oladipo et al., 2024).

### **High Implementation Costs**

AI implementation costs are high, especially for small, medium, and micro enterprises common in Africa. It requires money for technology, hardware, software, and skilled staff to develop, manage, and maintain systems. For SMMEs with limited resources, upfront costs for AI tools, machine learning models, and data infrastructure are a major barrier. Most commercial AI solutions do not fit African markets well, so firms pay extra for imports or build custom ones, increasing costs (Alice & Ebuka, 2024). Limited access to capital and low expected returns also discourage investment (Ebuka et al., 2023). Ongoing expenses for data storage, computing power, and experts add to the burden. High internet costs up to 44% of GDP in some African countries make AI adoption unaffordable for many (Arakpogun et al., 2021).

### **Shortage of Skilled Labor**

AI integration needs specialists like data scientists, machine learning engineers, and AI experts to develop, deploy, and manage systems (Enshassi et al., 2023). Many African countries lack these skills, making it a major barrier to AI in marketing (Proietti & Magnani, 2025). Companies must outsource to expensive foreign providers or use underqualified local staff, limiting AI's potential (Par, 2025; Shibiti et al., 2023). Education systems in Africa often fail to offer strong AI and machine learning programs, reducing the supply of experts (Kedi et al., 2024). Non-technical leaders also lack understanding of AI's benefits, slowing adoption (Anjorin et al., 2024).

### **Data Privacy and Security Concerns**

Given the heavy reliance of AI systems on data, privacy and security concerns pose a major barrier. In Africa, consumers are often reluctant to share personal data due to fears of misuse, identity theft, and privacy breaches. Without strong regulations and data protection laws, businesses face customer resistance to AI marketing tools. Africa's varied regulatory landscape worsens this: South Africa has advanced data protection laws, but many countries lack comprehensive frameworks. This ambiguity hinders firms from properly managing legal requirements for data collection, storage, and processing in line with local laws (Alice & Ebuka, 2024). Regulatory differences complicate compliance for cross-border businesses and erode trust in AI data use (Yadav, 2025).

### **Regulatory and Policy Challenges**

The lack of uniform AI policies and regulations across African countries poses a major barrier. While some countries are developing frameworks for AI and digital transformation, many others lag. This absence of consistent policies creates uncertainty for businesses considering AI adoption, especially regarding legal compliance and ethical issues. Moreover, regulatory differences between countries prevent pan-African businesses from implementing standardized AI systems. For example, variations in data protection laws, consumer rights, and digital marketing rules increase complexity in cross-border operations, leading to inefficiencies and higher costs (Alice & Ebuka, 2024). This regulatory fragmentation not only impedes technological diffusion but also stifles the development of regional AI ecosystems, crucial for nurturing local innovation and talent (Nibigira et al., 2024). Consequently, the absence of clear governmental directives on AI governance, coupled with inconsistent national data policies, significantly inhibits the scaling of AI solutions and cross-border data flow, essential for robust AI-driven marketing strategies (Anjorin et al., 2024; Tibokbe & Shankar, 2025).

## **3.3 The Impact of AI on Operational Efficiency**

Artificial intelligence is profoundly transforming operational efficiency across diverse business sectors. Organisations are progressively incorporating AI-enabled systems to optimise processes, mitigate human error, and augment productivity. By automating repetitive tasks, AI enables employees to concentrate on higher-value strategic functions, thereby enhancing overall operational performance. For example, AI-driven chatbots facilitate continuous management of customer enquiries, thereby reducing the necessity for extensive support teams while ensuring timely responses. Furthermore, AI's proficiency in analysing vast datasets with remarkable rapidity allows enterprises to refine operations in real time. In manufacturing, predictive maintenance employs AI to anticipate equipment failures preemptively, thereby averting costly disruptions and prolonging machinery longevity. These predictive applications extend to sectors such as energy, logistics, and healthcare, where they proactively address potential issues to sustain seamless operations. Moreover, AI is reshaping supply chain management through improved visibility and coordination. Machine learning algorithms forecast demand variations, optimise inventory levels, and streamline logistics, ensuring efficient and punctual product delivery. This approach not only curtails operational costs but also

elevates customer satisfaction. As AI technologies advance, their influence on operational efficiency will intensify, enabling businesses to operate more effectively and sustain competitiveness in dynamic markets (Vásquez, 2025). The integration of AI in business operations facilitates significant efficiency gains through automation and enhanced decision-making capabilities (Aljabari et al., 2024; Bruno, 2024).

### **Enhancing Customer Experience with AI**

AI transforms customer experience through personalized, interactive engagements. Using algorithms and natural language processing, AI analyzes customer behaviors, preferences, and feedback to deliver tailored interactions. Platforms like Amazon and Netflix demonstrate this via AI-driven recommendations, which increase satisfaction by providing relevant products and content. AI chatbots and virtual assistants such as Siri, Alexa, and Google Assistant enable instant, accurate query responses, handle complex transactions, and offer proactive support. This responsiveness boosts satisfaction and fosters loyalty through convenience and speed. AI further improves support by integrating omnichannel data for a unified customer journey, ensuring consistent, personalized service across channels. As AI evolves, companies will innovate to enhance engagement and build lasting relationships (Vásquez, 2025). This granular approach to understanding and predicting customer needs ultimately contributes to increased customer retention and sustained market differentiation (Olutimehin et al., 2024; Rahman, 2024).

### **AI-Driven Decision Making: A Game Changer**

AI-driven decision-making is transforming business strategies and operations. Using machine learning and advanced analytics, organizations make more informed, data-driven decisions. AI processes vast datasets to identify patterns, trends, and correlations often missed by human analysts, enabling proactive actions, risk reduction, and opportunity capture (Aljabari et al., 2024). A key benefit is real-time insights, essential in finance for timely investments and risk management, where AI analyzes market dynamics, predicts stock movements, and recommends ways to maximize returns. In marketing, real-time analysis of consumer behavior supports dynamic campaign adjustments and greater effectiveness. AI also improves strategic planning by providing a full environmental view; for example, predictive analytics forecasts market trends, customer demand, and competitive shifts to aid strong strategy development. This forward-looking approach helps businesses stay competitive amid uncertainties. As AI advances, its role in decision-making will expand, driving growth and innovation (Vásquez, 2025).

### **The Role of AI in Data Analysis and Insights**

Data, often called the "new oil," is refined by AI into actionable insights from large datasets. AI tools transform data collection, processing, and interpretation in organizations. Unlike traditional methods, which are labor-intensive and limited in scope, AI handles vast datasets quickly and accurately, revealing insights into strategic decisions. A key strength of AI in data analysis is its ability to detect patterns and trends that humans overlook. Machine learning algorithms analyze data to identify correlations and anomalies, providing deeper understanding of organizational performance. For example, in retail, AI examines sales data to uncover purchasing patterns, customer preferences, and seasonal trends, enabling better inventory management and marketing strategies. AI also enhances prediction, allowing organizations to forecast emerging trends and take proactive steps. Predictive analytics anticipates customer needs, market changes, and operational risks, improving planning and reducing future problems. This forward-looking approach is vital in volatile industries for maintaining competitiveness. As AI evolves, its role in data analysis and insights will become central to business strategy and growth (Vásquez, 2025).

### **Automating Routine Tasks: Benefits and Challenges**

AI automation of routine tasks is transforming the workplace, offering major benefits and challenges. A primary benefit is reducing manual labor, freeing employees for strategic and creative work. For instance, AI software handles data entry, scheduling, and similar repetitive tasks, boosting efficiency and minimizing errors. Automation also increases productivity through continuous operations without fatigue or breaks. AI systems run 24/7, maintaining critical functions beyond standard hours. This is especially useful in customer service and manufacturing, where downtime leads to significant losses. However, AI automation raises challenges that require careful management. The main issue is job displacement, as some roles may become obsolete. Organizations must address this through reskilling and upskilling programs to prepare workers for roles needing human creativity and strategy. Additionally, implementing AI infrastructure requires high investments, which burdens smaller firms. Despite these obstacles, automation's gains in efficiency and productivity make it essential for forward-thinking organizations (Vásquez, 2025).

### 3.4 Gaps in Current Literature

A major research gap exists in AI adoption among rural South African small, medium, and micro enterprises. Most studies focus on urban SMEs, leaving limited empirical evidence for rural SMMEs and excluding them from digital transformation efforts (Chasaya & Ayandibu, 2025). Without this evidence, AI promotion interventions may suit only urban settings and mismatch rural SMME needs. As a result, policies and programs for AI uptake may overlook rural challenges. ICT adoption studies among rural SMMEs show only 11% proficiency in using technologies, though most seek training. Future research should prioritize rural SMMEs to gain detailed insights into barriers, enabling tailored training and equitable policies. AI also holds potential to boost productivity and access to services in rural communities. Equitable access to Fourth Industrial Revolution (4IR) technologies is vital for rural SME sustainability, competitiveness, and socioeconomic growth. Thus, research on AI adoption in rural SMMEs is a key part of rural entrepreneurship needs expansion (Chasaya & Ayandibu, 2025).

- **Sectoral Gaps:** AI adoption research in South African SMEs centres on manufacturing, with few studies in other sectors. This creates a lack of evidence on sector-specific challenges and opportunities, limiting targeted interventions. Future research should focus on services, agriculture, retail, tourism, and healthcare for a fuller view of AI integration barriers and benefits.
- **Government Policies and Capacity Building:** Research on AI adoption in South African SMEs often covers challenges, opportunities, and influencing factors. Findings from ICT adoption in rural SMMEs highlight the need for capacity-building to convert perceived benefits into real adoption and sustainability. Addressing challenges will support AI adoption, implementation, and long-term success.
- **Limited empirical work examines how government policies, regulations, and frameworks affect AI adoption in SMEs:** Given SMEs' role in economic growth, assessing policy impacts is key to promoting innovation and performance. For instance, Bester found that missing policy guidance hindered AI use in rural municipalities. Willie and Mbongwe noted varied views on government support, with larger firms more positive than smaller ones. Future studies should evaluate programs accelerating AI adoption across rural and urban SMEs. Such research is crucial for developing targeted initiatives that bridge the technological divide and foster equitable AI-driven growth across diverse firm sizes and geographic locations (Ayinaddis, 2025; Sheik, 2023).

## 4. Results and Discussion

### Theoretical and Conceptual Framework

This section outlines theoretical and conceptual models that underpin the strategic framework for AI adoption in Small, Medium, and Micro Enterprises. The conceptual framework of this study integrates three key theories of innovation adoption: the Technology-Organisation-Environment framework, the Diffusion of Innovations theory, and the Technology Acceptance Model. These theories collectively explain how AI-related competencies alleviate perceived barriers, enhance perceived benefits, and ultimately improve operational efficiency in South African SMMEs.

From the TOE perspective, the technological context emphasises factors such as perceived complexity, compatibility with existing processes, and relative advantages; the organisational context highlights internal resources, including digital competencies and managerial readiness; whereas the environmental context encompasses external pressures and supportive structures, such as training providers, incubators, and industry associations. The DoI theory augments this view by demonstrating how innovation diffusion accelerates when complexity decreases, observability and trialability increase, and clear benefits for efficiency and competitiveness emerge. TAM, meanwhile, provides the behavioural dimension, positing that adoption primarily depends on users' perceptions of ease of use and usefulness in AI-enabled technologies.

Collectively, these frameworks indicate that AI competencies spanning data literacy, prompt engineering, workflow automation, and basic analytics directly reduce perceived complexity and enhance perceived ease of use. These skills also amplify perceived usefulness by empowering SMMEs to recognise AI's potential for optimising workflows, improving decision-making, and minimising operational inconsistencies. Training approaches, such as micro-learning and peer learning networks, act as enablers that improve the observability, trialability, and relevance of AI tools to daily operations. Support from Technical and Vocational Education and Training institutions, incubators, chambers of commerce, and vendor-provided sandboxes strengthens the environmental elements of TOE, while reinforcing

Dol's communal learning processes and TAM's acceptance pathways. Within this integrated model, strengthened AI skills reduce uncertainty, build confidence, expand capabilities, and drive higher adoption rates, resulting in measurable efficiency gains, including faster processing, reduced errors, and data-informed decisions.

#### **Derived Propositions:**

- Greater proficiency in AI-related competencies reduces the perceived complexity of AI technologies, thereby increasing adoption intentions.
- SMMEs' awareness of AI tool's utility in their operational workflows promotes higher adoption and associated efficiency improvements.
- Supportive structures enhance observability, trialability, and organisational readiness, thereby strengthening the adoption process.
- The incorporation of AI-enabled tools mediates the relationship between skills development and operational efficiency outcomes.

## **5. Strategy Framework (Findings from Literature)**

### **Role-Based Competencies**

The proposed strategy framework specifies essential role-specific competencies that enable small, medium, and micro enterprises to effectively leverage artificial intelligence tools for operational improvements. These include data literacy, which equips owners and staff to interpret dashboards, prepare basic datasets, and make decisions based on real-time insights. Expertise in prompt engineering is essential for utilising generative AI in areas such as customer service communications, marketing content, documentation, and problem diagnostics. Introductory skills in workflow automation allow employees to automate repetitive tasks like scheduling, invoicing, and reporting using low-code/no-code AI platforms. Basic analytics capabilities enable businesses to identify trends, detect inefficiencies, and monitor performance metrics, thereby supporting robust operational decision-making. Together, these competencies provide a practical basis for AI-driven efficiency gains in small business environments. Furthermore, a phased investment approach to AI technologies beginning with accessible tools and advancing to specialised solutions aligns expenditures with an organisation's evolving AI maturity and proven returns on investment (Hussain & Rizwan, 2024). This methodical progression allows SMEs to incrementally adopt AI, transitioning from basic applications to advanced implementations as internal capabilities and comprehension develop (Mustafa et al., 2025).

### **Learning Pathways**

Given the time and financial constraints of SMMEs, academic literature recommends flexible, cost-effective, and modular training pathways. Micro-learning, delivered through short mobile modules, allows employees to acquire skills without disrupting primary business functions. Micro-credentials offer competency-focused certifications that validate specific AI skills while maintaining accessibility and adaptability. Peer learning networks, facilitated by business chambers, incubators, or SMME community groups, leverage collective knowledge exchange to enable owners to share practical experiences and collaboratively resolve challenges. These approaches foster affordable training models, providing small firms with relevant, experiential development free from extended or expensive programmes. Emphasising both technical and non-technical proficiencies, these pathways are vital for cultivating an AI-capable workforce and securing long-term productivity benefits (Huseyn et al., 2024; OECD, 2025; Singh et al., 2024).

### **Toolkits**

The strategy framework incorporates practical toolkits for immediate AI integration into SMME operations. Vendor-neutral, low-cost AI tools such as chatbots, automation platforms, and analytics dashboards enable experimentation without commitment to expensive proprietary systems. Data readiness checklists assist SMMEs in structuring, cleansing, and governing data to optimise AI tool performance. Process mapping templates facilitate workflow visualisation, bottleneck identification, and targeting of automation or AI-assisted decision-making opportunities. These resources promote practical implementation and ensure AI adoption aligns with genuine business requirements.

### **Partnerships**

Strategic partnerships play a crucial role in advancing AI competency development and adoption among SMMEs. TVET institutions provide localised training programmes tailored to SMME needs. Incubators and innovation hubs offer testing sandboxes, mentorship, and technical support. Chambers of commerce facilitate peer learning, knowledge sharing, and network integration. Technology vendors supply free or subsidised trial platforms, templated resources,

and onboarding assistance. Together, these collaborations create an enabling ecosystem that supports skill building, boosts confidence, and accelerates AI tool integration. Public-private partnerships and regional initiatives enhance these efforts with industry expertise and focused funding, while entrepreneurial ecosystems deliver essential training, mentorship, and collaboration opportunities (OECD, 2025).

### **Governance & Readiness**

Effective governance frameworks ensure systematic, secure, and strategically aligned AI integration in SMMEs. Streamlined data governance protocols including core data management guidelines and privacy protections build trust in digital systems. Leadership commitment is essential for prioritising AI initiatives, allocating resources to skills development, and modelling adoption behaviours. Tracking key performance indicators quantifies AI's impact on operational efficiency, output quality, and productivity, providing data to inform decisions and continuous improvements. These mechanisms convert competencies and tools into sustainable operational enhancements beyond initial trials.

### **6. Conclusion**

In conclusion, remedying the AI competency shortfall in South African SMMEs requires a holistic strategy that encompasses core AI skills, feasible training pathways, and supportive institutional structures. The proposed framework prioritises data literacy, basic automation, and analytics as foundational skill areas; advocates micro-learning, short courses, and affordable digital resources as practical delivery mechanisms; and highlights TVET colleges, incubators, and innovation hubs as key enablers. Empirical findings demonstrate that advancing AI skills substantially enhances operational efficiency through accelerated processes, error reduction, and strengthened data-driven decision-making. Consequently, policymakers and support entities are encouraged to prioritise SMME-focused AI upskilling programmes, strengthen public-private partnerships for digital capacity building, and introduce subsidised training for small businesses. Future research should empirically test this framework in real-world SMME contexts, evaluate the effectiveness of specific training methods, and identify sector-tailored AI adoption requirements in domains like retail, manufacturing, and agriculture. Such studies will enrich insights into AI's transformative role across varied economic sectors and guide the creation of context-appropriate support systems.

### **References**

- Adigwe, C.S. et al., Forecasting the future: The interplay of artificial intelligence, innovation, and competitiveness and its effect on the global economy, *Asian Journal of Economics, Business and Accounting*, vol. 24, no. 4, p. 126, 2024.
- Akoh, E., Adoption of artificial intelligence for manufacturing SMEs' growth and survival in South Africa: A systematic literature review, *International Journal of Research in Business and Social Science*, vol. 13, no. 6, p. 23, 2024.
- Alice, S. and Ebuka, O., The potential and challenges of AI adoption in marketing across Africa, *Business and Investment Review*, vol. 2, no. 6, p. 1, 2024.
- Aljabari, M. et al., The impact of digital marketing strategies on innovation: The mediating role of AI: A critical study of SMEs in the KSA market, *International Journal of Data and Network Science*, vol. 8, no. 4, p. 2029, 2024.
- Anjorin, K.F. et al., Harnessing artificial intelligence to develop strategic marketing goals, *International Journal of Management and Entrepreneurship Research*, vol. 6, no. 5, p. 1625, 2024.
- Arakpogun, E.O. et al., Artificial intelligence in Africa: Challenges and opportunities, in *Studies in Computational Intelligence*, Springer Nature, p. 375, 2021.
- Ayinaddis, S.G., Artificial intelligence adoption dynamics and knowledge in SMEs and large firms: A systematic review and bibliometric analysis, *Journal of Innovation and Knowledge*, vol. 10, no. 3, article 100682, 2025.
- Bruno, Z., The impact of artificial intelligence on business operations, *Global Journal of Management and Business Research*, p. 1, 2024.
- Chasaya, W. and Ayandibu, A., Positioning South African SMEs for the artificial intelligence-driven future: A review of adoption challenges, opportunities and gaps, *Business Ecosystem and Strategy*, vol. 7, no. 5, p. 235, 2025.
- Ebuka, A.A., Emmanuel, D. and Idigo, P.I., Artificial intelligence as a catalyst for the sustainability of small and medium scale businesses (SMEs) in Nigeria, *Annals of Management and Organization Research*, vol. 5, no. 1, pp. 1–15, 2023.
- Enshassi, M. et al., Potentials of artificial intelligence in digital marketing and financial technology for small and medium enterprises, *IAES International Journal of Artificial Intelligence*, vol. 13, no. 1, p. 639, 2024.

- Eyeregba, M.E. et al., Harnessing artificial intelligence for business optimization: Enhancing efficiency and sustainability in SMEs, *International Journal of Management and Entrepreneurship Research*, vol. 6, no. 12, p. 3844, 2024.
- Giwa, F. and Ngepah, N., The relationship between artificial intelligence and low-skilled employment in South Africa, *Heliyon*, vol. 10, no. 23, 2024.
- Holland, J., Artificial intelligence adoption for sustainable development in SMEs: Challenges, strategic pathways, and lessons for developing economies, *International Journal of Sustainability in Business and Economics*, vol. 2, no. 1, 2026.
- Huseyn, M. et al., Adoption of artificial intelligence in small and medium-sized enterprises in Spain: The role of competences and skills, *Amfiteatru Economic*, vol. 26, no. 67, pp. 848–866, 2024. <https://doi.org/10.24818/ea/2024/67/848>
- Hussain, A.K. and Rizwan, R., Strategic AI adoption in SMEs: A prescriptive framework, *arXiv*, 2024. <https://doi.org/10.48550/arXiv.2408.11825>
- Kedi, W.E. et al., Machine learning software for optimizing SME social media marketing campaigns, *Computer Science and IT Research Journal*, vol. 5, no. 7, 2024.
- Kumar, N. and Shrivastava, A., The artificial intelligence (AI) revolution: Evolving business decision-making in the digital age, *SAGE Open*, vol. 42, no. 3, 2025.
- Madondo, E., Akindeji, E.B. and Ogunsola, S.A., The role of innovative entrepreneurship and emerging technologies in South Africa's small, medium and micro enterprises, *International Journal of Research in Business and Social Science*, vol. 13, no. 7, pp. 585–596, 2024.
- Mustafa, H.N., Ghani, N.I.A. and Adam, A., Enhancing performance in SMEs: A conceptual framework for AI adoption through digital readiness and employee digital skills, *International Journal of Entrepreneurship and Management Practices*, vol. 8, no. 31, p. 226, 2025.
- Mweha, S.D., Operationalising ethical AI: A governance framework for generative AI adoption in Sub-Saharan African SMEs, *International Journal of Research and Innovation in Social Science*, vol. 10, no. 1, p. 1245, 2026.
- Nibigira, N., Havyarimana, V. and Xiao, Z., Artificial intelligence adoption for cybersecurity in Africa, *Journal of Information Security*, vol. 15, no. 2, p. 134, 2024.
- Nwagbala, S.C. et al., AI adoption and sustainability of SMEs in Africa: Opportunities and challenges, *International Journal of Science and Research Archive*, vol. 14, no. 1, p. 467, 2025.
- OECD, AI adoption by small and medium-sized enterprises, *OECD Publishing eBooks*, 2025.
- Okoye, C.C. et al., Accelerating SME growth in the African context: Harnessing FinTech, AI, and cybersecurity for economic prosperity, *International Journal of Science and Research Archive*, vol. 11, no. 1, p. 2477, 2024.
- Oladipo, E.K. et al., Impact and challenges of artificial intelligence integration in the African health sector: A review, *Trends in Medical Research*, p. 220, 2024.
- Olutimehin, D.O. et al., Implementing AI in business models: Strategies for efficiency and innovation, *International Journal of Management and Entrepreneurship Research*, vol. 6, no. 3, p. 863, 2024.
- Osasona, F. et al., AI integration in business analytics: A review of USA and African trends, *Computer Science and IT Research Journal*, p. 432, 2024.
- Par, A., A scalable AI framework for SMEs and a novel metric: Proactive Adaptation Rate (PAR), *DergiPark Preprint*, 2025.
- Pillai, R., South Africa's AI future: Bridging the critical skills gap, 2025. <https://cbn.co.za/industry-news/robotics-ai-news/south-africas-ai-future-bridging-the-critical-skills-gap/>
- Prazeres, F.G. and Pina, A.J. da S., AI integrated learning for higher education social science educators, *DergiPark Preprint*, 2024. <https://dergipark.org.tr/tr/pub/usdad/issue/86150/1529088>
- Proietti, S. and Magnani, R., Assessing AI adoption and digitalization in SMEs: A framework for implementation, *arXiv*, 2025. <https://doi.org/10.48550/arXiv.2501.08184>
- Rahman, A., AI and machine learning in business process automation: Innovating ways AI can enhance operational efficiencies or customer experiences in U.S. enterprises, *Non Human Journal*, vol. 1, no. 1, p. 41, 2024. <https://doi.org/10.70008/jmldeds.v1i01.41>
- Sheik, I., Navigating the digital divide: Exploring the multifaceted 4IR challenges and technological disparities encountered by SMMEs within KwaZulu-Natal, South Africa, *Technology Audit and Production Reserves*, vol. 5, p. 6, 2023. <https://doi.org/10.15587/2706-5448.2023.287784>
- Shibiti, R., Masabo, T.T. and Ladzani, W., Readiness of SMMEs for the adoption of the fourth industrial revolution in Mamelodi Township, *International Journal of Research in Business and Social Science*, vol. 12, no. 8, p. 33, 2023. <https://doi.org/10.20525/ijrbs.v12i8.2986>

- Sibiya, A., van der Westhuizen, J. and Sibiya, B.S., Challenges experienced by SMMEs and interventions by the South African national and provincial government: A literature review, *African Journal of Inter/Multidisciplinary Studies*, vol. 5, no. 1, pp. 1–11, 2023.
- Singh, N. et al., Transforming business with generative AI: Research, innovation, market deployment and future shifts in business models, *arXiv*, 2024. <https://doi.org/10.48550/arXiv.2411.14437>
- Stević, Ž. et al., Sustainable supplier selection in healthcare industries using a new MCDM method: Measurement of alternatives and ranking according to compromise solution (MARCOS), *Computers and Industrial Engineering*, vol. 140, 2020.
- Tibokbe, V.P. and Shankar, S., The usefulness of emerging technologies in the FMCG industry (underdeveloped markets), *American Journal of Industrial and Business Management*, vol. 15, no. 2, pp. 292–314, 2025. <https://doi.org/10.4236/ajibm.2025.152015>
- Twabu, K., Investigating Schumpeter's innovation theory in the context of AI in higher education research, *Discover Education*, vol. 4, no. 1, 2025. <https://doi.org/10.1007/s44217-025-00855-2>
- Utilization of artificial intelligence in organizational sustainable development: Bibliometric analysis and future research directions, *Scientific Papers of Silesian University of Technology: Organization and Management Series*, no. 223, 2025. <https://doi.org/10.29119/1641-3466.2025.223.27>
- Vásquez, L., How AI is revolutionizing business operations and driving growth, 2025. <https://urbeuniversity.edu/blog/how-ai-is-revolutionizing-business-operations-and-driving-growth>
- Vilma, A. and Booshnam, D., Agility toward the HRIS advancement at the organization and its impact on performance in SMEs, *Journal of Small Business Strategy*, vol. 35, no. 3, 2025.
- Weilbach, N., Bridging the digital divide: AI adoption for SMME sustainability in resource-constrained regions, *Open Journal of Business and Management*, vol. 13, no. 2, p. 1289, 2025.
- Yadav, J., Artificial intelligence: A paradigm shift in marketing, *International Journal for Research in Applied Science and Engineering Technology*, vol. 13, no. 9, p. 2222, 2025.
- Yusuf, S.O. et al., Challenges and opportunities in AI and digital transformation for SMEs: A cross-continental perspective, *World Journal of Advanced Research and Reviews*, vol. 23, no. 3, p. 668, 2024.
- Závodná, L.S., Überwimmer, M. and Frankus, E., Barriers to the implementation of artificial intelligence in small and medium sized enterprises: Pilot study, *Journal of Economics and Management*, vol. 46, p. 331, 2024.
- Zhou, H., Chamba, L.T. and Zondo, R.W.D., Application of explainable artificial intelligence technique to model the predictors of South African SMMEs resilient performance during the COVID-19 pandemic, *International Journal of Research in Business and Social Science*, vol. 13, no. 1, p. 64, 2024.

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