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SME readiness for Industry 5.0: A systematic literature review

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Background: The readiness of South African small and medium enterprises (SMEs) for Industry 5.0 plays a pivotal role in fostering economic growth, integrating advanced technologies and promoting sustainable practices. Despite their importance, the adoption of Industry 5.0 technologies among SMEs in South Africa varies significantly across sectors because of infrastructural, financial and workforce challenges.

Aim: This study systematically reviews the readiness of South African SMEs for Industry 5.0, examining the adoption of advanced technologies such as artificial intelligence (AI) and Internet of Things (IoT) and their economic implications. It identifies key readiness factors, sector-specific challenges and opportunities to propose actionable strategies for improvement.

Setting: Industry 5.0 technology adoption among SMEs in South Africa differs widely across sectors, influenced by variations in infrastructure, workforce skills and financial capacity.

Methods: We conducted a systematic review of 10 studies using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) approach to synthesise Industry 5.0 adoption rates, workforce capabilities, sustainability practices, and economic impacts.

Results: South African SMEs are gradually adopting Industry 5.0 technologies, although progress varies across sectors. Workforce training, financial investment and digital infrastructure emerge as critical enablers.

Conclusion: Industry 5.0 readiness is crucial for economic growth among South African SMEs. Sector-specific strategies and policy support are essential for overcoming existing challenges.

Contribution: This study provides a framework for assessing Industry 5.0 readiness in South African SMEs and offers evidence-based recommendations for enhancing technological adoption in resource-constrained environments.

Keywords: Industry 5.0 readiness; SMEs; South Africa; economic growth; digital transformation; sustainability practices; technology adoption; workforce development.

Introduction

Industry 5.0 is the subsequent stage in developing industrial practices, expanding on the principles of Industry 4.0. In contrast to Industry 4.0, which prioritises automation and data-centric methodologies, Industry 5.0 positions humans at the core of technological advancement, promoting collaborative interactions between humans and machines to improve creativity, problem-solving and productivity (Zafar, Langås & Sanfilippo 2024). The Industry 5.0 paradigm amalgamates human intelligence with technologies like collaborative robotics and artificial intelligence (AI), fostering sustainable and ethically aligned production practices (Echegaray et al. 2022). This human-centric paradigm seeks to enhance staff adaptability and job happiness, enabling small and medium enterprises (SMEs) to leverage innovation and productivity improvements that directly contribute to economic growth (Ansari et al. 2023). Industry 4.0 is centred around automation, data sharing and intelligent technologies in manufacturing. In contrast, Industry 5.0 goes beyond this by highlighting the integration of human labour with advanced technologies such as artificial intelligence, robotics and the Internet of Things (IoT) (Sony & Naik 2019). This integration aims to establish a mutually beneficial association between humans and machines, wherein each entity enhances the capabilities of the other, resulting in heightened efficiency, productivity and innovation in industrial operations (Ansari et al. 2023). Small and medium enterprises in South Africa represent more than 90% of registered businesses and account for roughly 34% of the national gross domestic product (GDP) (Fatoki 2021). Nevertheless, the overall digital adoption rate within the industry is deficient, especially in sectors

devoid of technology infrastructure and a skilled workforce (Garzoni et al. 2020). Restricted access to finance and infrastructural obstacles impede their preparedness for Industry 5.0, highlighting the necessity for customised support and resources across diverse sectors (Hasani et al. 2023).

Evaluating the preparedness of SMEs in South Africa for Industry 5.0 is essential for its economic growth, owing to various factors. Small and medium enterprises play a crucial role in the South African economy, substantially contributing to employment and GDP (Hanafiah, Soomro & Abdullah 2020). While assessing their preparedness for Industry 5.0, these SMEs may pinpoint the areas in which they must adjust and allocate resources towards new technologies and skills to maintain competitiveness in the rapidly changing industrial environment (Pirola, Cimini & Pinto 2019). Furthermore, evaluating the preparedness of SMEs for Industry 5.0 enables them to synchronise their operations with worldwide benchmarks and optimal methods, empowering them to engage more efficiently in global markets and supply chains (Samaranayake 2023). South African SMEs encounter various obstacles to Industry 5.0, including insufficient financial resources for investment in advanced digital technologies and inadequate infrastructure (Garzoni et al. 2020). Furthermore, SMEs frequently encounter difficulties in sourcing qualified individuals for the implementation of Industry 5.0, which necessitates specialised expertise in automation, AI and IoT (Hasani et al. 2023). Furthermore, the substantial expenses associated with infrastructure maintenance and the sluggish evolution of regulatory frameworks further impede SMEs' preparedness for digital transformation in South Africa (Rambaruth, Adam & Krishna 2022).

Research gap and objectives

In order to fill the research void in the current body of literature about the preparedness of South African SMEs for Industry 5.0, it is essential to thoroughly examine existing studies and identify areas that have not been sufficiently investigated. Although there is an increasing amount of research on the preparedness of SMEs for Industry 4.0 and its worldwide ramifications, there is a need for more studies that specifically examine the preparation of South African SMEs for Industry 5.0. The existing research primarily focuses on the practices and implementation of Industry 4.0, with insufficient investigation into the distinct challenges, possibilities and consequences of transitioning to Industry 5.0 for SMEs in South Africa (Maisiri & Dyk 2019).

A research gap in the existing literature is the absence of a thorough evaluation of the factors that impact the preparedness of South African SMEs for Industry 5.0. Although previous studies have partially explored digital transformation, technology adoption and innovation readiness in SMEs (Garzoni et al. 2020; Hasani et al. 2023; Maisiri & Dyk 2019; Venter & Hayidakis 2021), there is a requirement for a more targeted examination of the preparedness of SMEs in South Africa regarding Industry 5.0 practices. Gaining a comprehensive understanding of the unique preparedness indicators, difficulties and enablers associated with Industry 5.0 can offer valuable insights for policymakers, industry stakeholders and SMEs to manage the transition successfully.

In light of these identified gaps in the literature, the main objectives of this study on assessing Industry 5.0 readiness and its impact on South African SMEs are to:

1. *Explore the unique challenges and opportunities associated with Industry 5.0 adoption for SMEs in South Africa.*
2. *Identify the key factors influencing Industry 5.0 readiness among South African SMEs.*

This study intends to provide valuable insights into the Industry 5.0 readiness assessment and its implications for SMEs in South Africa by addressing research questions and filling gaps in the existing literature.

Literature review

Industry 5.0 is the most recent stage in developing industrial practices, which builds upon the groundwork established by Industry 4.0. Industry 4.0 is centred on automation, data interchange and intelligent technologies in manufacturing. In contrast, Industry 5.0 goes beyond that by highlighting the fusion of human labour with advanced technologies such as artificial intelligence, robotics and the IoTs (Rahmani et al. 2023). This integration aims to establish a mutually beneficial connection between humans and machines, wherein each entity enhances the strengths of the other, resulting in higher levels of efficiency, productivity and innovation in industrial operations.

Industry 5.0 has emerged from Industry 4.0, primarily focusing on integrating human workers into industrial processes alongside technological technologies. Industry 5.0 expands on the concepts of automation and digitalisation introduced by Industry 4.0, emphasising the cooperation between humans and machines to enhance innovation and efficiency (Echegaray et al. 2022). The transition from Industry 4.0 to Industry 5.0 is a move towards comprehensive and inclusive production processes that prioritise human well-being, environmental sustainability and consumer happiness.

Small and medium enterprises in South Africa

Small and medium enterprises are crucial to the South African economy, serving as catalysts for growth, innovation and job creation. Based on the Department of Trade and Industry (DTI 2020) data, SMEs comprise around 91% of registered businesses, contribute over 34% to the GDP and employ approximately 60% of the workforce. The significance of this sector is emphasised by its capacity to stimulate

economic diversification and resilience, particularly in a nation grappling with substantial socio-economic issues such as elevated unemployment and income disparity (Fatoki 2021).

Although SMEs in South Africa make significant contributions, they encounter distinct obstacles and opportunities when implementing Industry 5.0 technology (Fatoki 2021). A significant obstacle SMEs face is the limited financial resources and difficulty in obtaining capital to invest in cutting-edge technology and digital transformation (Madzimure, Mafini & Dhurup 2020). A significant challenge SMEs face is securing funding to improve their infrastructure, purchase new equipment and train their employees under Industry 5.0 standards (Rambaruth et al. 2022). Insufficient loan availability from established financial institutions poses a significant obstacle for SMEs to invest in cutting-edge technology and maintain competitiveness in the swiftly changing industrial environment (Hasani et al. 2023).

Despite financial constraints, skills shortages and regulatory hurdles, SMEs in South Africa have the potential to improve their competitiveness, efficiency and market presence through digital transformation, even though they face challenges in adopting Industry 5.0 technologies. By tackling these difficulties and capitalising on the possibilities offered by Industry 5.0, SMEs in South Africa have the potential to stimulate economic expansion, promote creativity and make a significant contribution to the nation's overall industrial advancement.

Industry 5.0 challenges for small and medium enterprises in South Africa

The advent of Industry 5.0, defined by the amalgamation of human intellect with advanced technologies, offers both prospects and obstacles for SMEs in South Africa. This literature review consolidates multiple studies to emphasise the problems SMEs face in adjusting to this new industrial paradigm.

A major challenge for SMEs in South Africa is the deficiency of effective leadership and management methods. Langton and Mafini (2022) asserted that deficient leadership substantially obstructs supply chain management in manufacturing SMEs. Mofokeng, Chinomona and Mafini (2023) asserted that internal innovation drivers are frequently impeded by inadequate management methods, resulting in sustainability challenges. The elevated failure rate of SMEs, with estimates indicating that 70% to 80% do not endure the past 5 years, highlights the imperative for proficient leadership and strategic planning (Dele-Ijagbulu, Eresia-Eke & Moos 2020; Dzomonda 2022).

Financial difficulties are widespread among SMEs in South Africa, intensified by restricted access to capital and resources. Fatoki (2021) emphasised that inadequate financial literacy among entrepreneurs results in suboptimal financial decisions, hence hindering their capacity to obtain essential capital. Rens et al. (2021) asserted that insufficient financial resources significantly constrain the growth potential of SMEs. The coronavirus disease 2019 (COVID-19) epidemic has exacerbated financial difficulties, causing numerous SMEs to struggle to sustain operations during lockdowns (Fubah & Moos 2022; Sonandi, Ladzani & Nealer 2021).

The shift to Industry 5.0 requires substantial technological adaptation; nevertheless, several South African SMEs are delayed in embracing digital tools. Ademola (2023) examined the numerous factors that impede the digital transformation of SMEs, which is essential for competitiveness in the Industry 5.0 environment. The hesitation to use e-commerce and digital platforms, as seen by Ramsern and Govender (2023), underscores SMEs' difficulties in modernising their operations. This technology disparity constrains SMEs' market access and impairs their operational efficiency and innovative potential.

Globalisation has heightened competition for local SMEs, complicating their ability to prosper in the face of larger, more established enterprises. Masocha (2019) indicated that heightened competition from domestic and international entities exerts more pressure on SMEs, who frequently lack the means to compete effectively. The competitive environment is exacerbated by marketing and brand visibility issues, as noted by Ayandibu et al. (2019), who examine the limitations that impede the viability of small enterprises in South Africa.

Human resource constraints also provide considerable difficulties for SMEs. The deficiency of skilled labour and insufficient training programmes constrain the capacity of SMEs to develop and adapt to emerging technologies (Mudara & Mafini 2022; Saah 2023). Furthermore, the elevated unemployment rate in South Africa hinders the recruitment of qualified individuals as several prospective employees lack the requisite skills and experience (Fatoki 2021; Ramasimu, Ramasimu & Nenzhelele 2023). The skills gap is especially harmful in the context of Industry 5.0, which depends significantly on a workforce capable of integrating modern technologies with human creativity and problem-solving abilities. Small and medium-sized enterprises in South Africa encounter complex hurdles in transitioning to Industry 5.0. Deficiencies in leadership, budgetary limitations, obstacles in technical adaptation, heightened market competitiveness and human resource issues collectively impede their capacity to prosper in this changing industrial environment. Confronting these difficulties necessitates a collaborative endeavour between the government and the private sector to establish a conducive ecosystem that promotes innovation, facilitates access to funds and improves workforce skills.

Economic impact of Industry 5.0

To assess the potential impact of Industry 5.0 on SMEs' economic growth, it is crucial to examine previous research on

the financial consequences of advanced technologies on SMEs. Multiple studies have emphasised the importance of incorporating technology to improve SMEs' performance and long-term viability. Pu et al. (2021) highlighted that a company's competitive edge is enhanced by its incorporation of technology, which is influenced by the attitudes of owners and management (Pu et al. 2021). Furthermore, Vrontis, Chaudhuri and Chatterjee (2022) highlighted that incorporating digital technology enhances both economic and social worth, resulting in a beneficial influence on the performance of SMEs (Vrontis et al. 2022). These studies emphasise the significance of technological adaptation for SMEs' long-term viability and ability to generate value.

A paper by Prasanna et al. (2019) emphasised that technological advances can accelerate economic growth, namely by boosting the performance of SMEs through technical advancements (Prasanna et al. 2019). Jaish et al. (2023) discovered that the use of advanced digital technologies can significantly enhance the productivity of SMEs, demonstrating the favourable influence of digitalisation on SMEs (Jaish et al. 2023). These studies illustrate that technical improvements are essential in stimulating economic growth and improving the performance of SMEs.

Beyond that, implementing Industry 5.0 principles can empower SMEs to maintain a competitive edge, adjust to shifts in the market and fulfil changing client needs. By utilising Industry 5.0 technology, SMEs can improve their ability to adapt quickly, respond effectively and expand their operations, positioning themselves for long-term growth and achievement in a swiftly evolving business landscape. Industry 5.0 can enable SMEs to succeed in the digital era by providing them with the necessary tools and competencies. This, in turn, promotes economic growth and prosperity.

The human-centric paradigm of Industry 5.0 substantially influences the economic performance of SMEs by improving operational efficiency and staff engagement. Studies indicate that collaborative robots and AI-enhanced human–machine systems can enhance productivity and lower operational expenses crucial for the competitiveness of SMEs in rapidly changing markets (Huang & Ichikohji 2023). Moreover, Industry 5.0's emphasis on sustainability corresponds with consumer expectations for eco-friendly practices, enabling SMEs to leverage green market opportunities and enhance their market positioning (Bacinello, Tontini & Alberton 2021). By concentrating on these Industry 5.0-driven elements, SMEs can attain economic resilience and sustainable growth despite resource limitations (Vrontis et al. 2022).

Industry 5.0 practices by small and medium enterprises

The shift to Industry 5.0, highlighting the synergy between humans and robots, offers distinct opportunities and difficulties for SMEs in South Africa. An important facet of this change is the incorporation of modern technologies, including the IoT and AI, into conventional business procedures. Adegbite and Govender (2021) asserted that the Fourth Industrial Revolution (4IR) is transforming the operational environment for SMEs, facilitating improvements in efficiency and creativity. The adoption of these technologies is frequently impeded by insufficient financial resources and technical competence, both of which are essential for their deployment. Chipunza and Mupani (2019) emphasised that numerous SMEs have challenges because of inadequate understanding of digital technologies, hence constraining their competitiveness in a progressively technology-oriented market. The disparity in technological adoption is especially evident in rural regions, where SMEs encounter further obstacles, including insufficient infrastructure and restricted access to training programmes (Ademola 2023).

Furthermore, government support and business incubators play a vital role in enabling SMEs to move to Industry 5.0. Ramasimu, Ramasimu and Nenzhelele (2023) asserted that focused governmental measures can markedly enhance the operational capacities of SMEs by facilitating access to capital, training and resources essential for technology integration. The creation of business incubators has demonstrated the ability to improve the sustainability of SMEs by providing mentorship and support specifically designed to address the distinct issues encountered by small enterprises (Msimango-Galawe & Hlatshwayo 2021). The efficacy of these initiatives frequently fluctuates as newer SMEs often exhibit a lack of information regarding available resources and support mechanisms (Ogujiuba et al. 2023). This gap highlights the necessity for a more unified strategy in policy implementation that guarantees all SMEs, irrespective of their maturity, may reap the benefits of breakthroughs linked to Industry 5.0. The interaction of technological adoption, governmental assistance and the distinct obstacles encountered by SMEs in South Africa is essential in determining the future economic landscape of the nation.

Research methods and design

The article adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) principles as prescribed for systematic literature reviews (Rethlefsen et al. 2021). The checklist comprises 27 items that encompass the fundamental elements of a systematic review, such as the title, abstract, introduction, methods, findings, commentary and funding sources (Spagnoli et al. 2021).

Hence, the PRISMA methodology offers a well-organised framework for systematic literature reviews. This framework encompasses tasks such as formulating search methods, setting criteria for including or excluding studies, and ensuring transparency in selecting relevant material. Adhering to the PRISMA criteria enables researchers to guarantee the excellence and dependability of their systematic reviews, resulting in significant insights and evidence-based findings regarding the influence of Industry 5.0 on SMEs and economic growth in South Africa.

Data extraction and analysis

Data extraction in a systematic literature review entails the organised gathering of pertinent data from chosen studies to address the research questions or objectives of the review. For the systematic literature review on Industry 5.0 preparedness and its impact on SMEs in South Africa, data extraction identified essential results, techniques, sample characteristics and outcomes from the chosen studies. Data extraction aims to combine and analyse the extracted data to get significant findings and insights from the literature (Govuzela & Mafini 2019; Makelana, Kekwaletswe & Segooa 2022; Madzimure et al. 2020).

For searching strings related to Industry 5.0, SMEs, economic growth, South Africa and technology adoption in Scopus, the search string in Box 1 was used.

The study screened literature for data on SME adoption rates and readiness specific to South Africa. Figure 1 depicts a PRISMA flow diagram that outlines the steps involved in discovering, screening and choosing articles for a systematic literature review on evaluating Industry 5.0's preparedness and its influence on the economic growth of SMEs in South Africa. The data used for this research were obtained from the Scopus database.

Identification phase

The identification process commences by retrieving records from the Scopus database. After meticulous database searches, 269 records were uncovered, and 59 duplicate entries were eliminated before screening to ensure that only distinct studies were included for further analysis. In addition, automation algorithms identified 21 records as ineligible. These methods are commonly used to screen studies based on their titles and abstracts according to specified criteria.

Screening phase

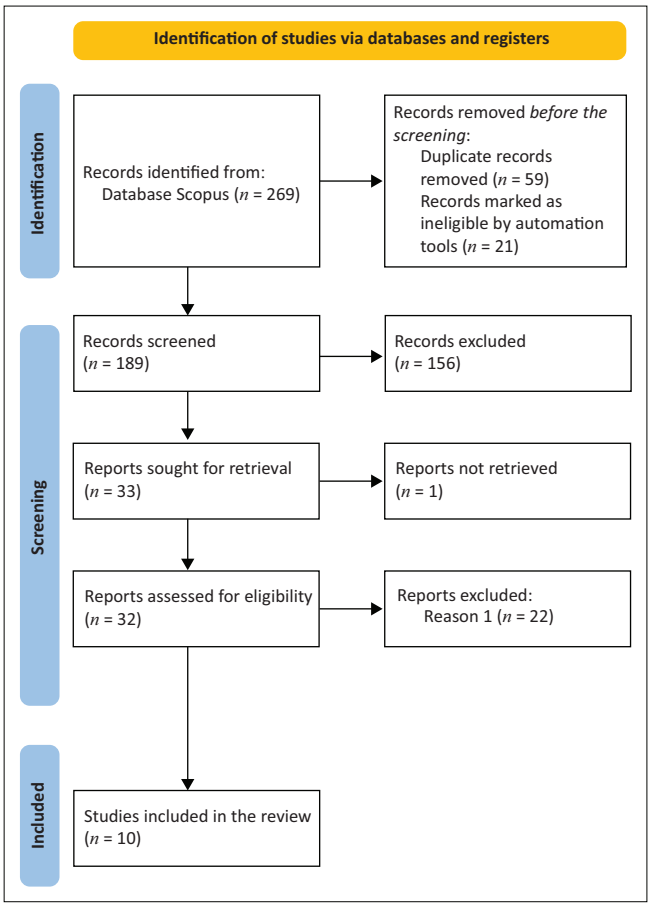
After eliminating duplicate and ineligible records, 189 records remained for the screening phase. Every document was examined to ascertain its pertinence to the research subject; 156 records were excluded from the screening process because of failing to meet the inclusion criteria. This thorough evaluation guarantees that only the most relevant studies go to the subsequent stage.

Eligibility phase

The eligibility phase entailed a thorough analysis of the remaining records. Efforts were made to obtain reports for retrieval, and 33 reports were recognised as potentially relevant and were sought for full-text retrieval. Nevertheless,

BOX 1: Scopus search string.

industry 5.0 OR industry AND five AND point AND zero AND small AND medium AND enterprises OR smes AND economic AND growth OR financial AND performance AND technology AND adoption OR digital AND transformation AND South Africa PUBYEAR > 2012 AND PUBYEAR < 2024 AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (OA, "all")) AND (LIMIT-TO (PUBSTAGE, "final")).



Source: Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D. et al., 2021, 'The PRISMA 2020 statement: an updated guideline for reporting systematic reviews', *International Journal of Surgery* 88, 105906

FIGURE 1: PRISMA flow diagram.

one report could not be obtained, decreasing the total number of reports evaluated for eligibility to 32. During the eligibility assessment, every report had a comprehensive analysis to verify its pertinence and compliance with the inclusion criteria. As a result, 22 publications were not included because they did not specifically focus on Industry 5.0, lacked appropriate data on SMEs in South Africa or did not adequately address economic consequences.

Inclusion phase

After the final inclusion phase, 10 studies were selected for the systematic literature review. These studies offered valuable insights into the preparedness of Industry 5.0 and its economic effects on SMEs in South Africa. These works are included to establish a foundation for a thorough study and synthesis of current knowledge in the field, which enhances our comprehension of the research issue. The PRISMA flow diagram clearly and systematically represents the rigorous methodology used in conducting a literature review. The graphic guarantees transparency and reproducibility in selecting studies by clearly illustrating each phase, including identification, screening, eligibility evaluation and final inclusion. The careful and thorough procedure highlights the trustworthiness and accuracy of the conclusions drawn from the systematic literature analysis on

the preparedness of Industry 5.0 and its influence on the economic growth of SMEs in South Africa.

The selection of 10 papers was informed by a stringent screening procedure that emphasised high-quality, contemporary studies pertinent to Industry 5.0 readiness among SMEs in South Africa. This methodology adheres to the best principles of systematic literature reviews, prioritising quality and contextual relevance over quantity to maintain focused and actionable findings (Page et al. 2021). Although increasing the sample size could have offered a more comprehensive perspective, our criteria mainly focused on studies that prominently addressed Industry 5.0 technologies, human–machine collaboration and the economic ramifications for SMEs. This emphasis guarantees that the review delivers a comprehensive and contextually pertinent analysis grounded in high-quality data sources rather than compromising the findings with less relevant literature (Hanafiah et al. 2020; Rethlefsen et al. 2021).

Thematic analysis, conducted using ATLAS.ti, is a qualitative approach to evaluating data. It entails the identification, analysis and reporting of patterns or themes present in the data. For a systematic literature review on Industry 5.0 and SMEs in South Africa, a thematic analysis was conducted using ATLAS.ti. This involved organising and classifying data extracted from chosen studies to identify recurring themes, concepts or patterns relevant to Industry 5.0's readiness, economic growth and the performance of SMEs. The researchers utilised ATLAS.ti software to organise and analyse the data systematically, enabling the identification of significant patterns and insights throughout the literature (Higgs & Hill 2018; Moinogu 2024; Moss & Thomas 2022).

Researchers employed ATLAS.ti to conduct thematic analysis, carefully examining and interpreting data from chosen studies. This process reveals significant insights and trends regarding the readiness of Industry 5.0 and its effects on SMEs in South Africa. Thematic analysis enables a systematic and organised way to combine the literature, yielding valuable insights to guide policy, practice and future studies.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Johannesburg's Department of Business Management Research Ethics Committee (No. 22SOM07).

Results

Figure 2 depicts a line chart named 'Documents by year', illustrating the quantity of papers generated from 2018 to 2023 over 6 years. The *y*-axis shows the number of documents, while the *x*-axis represents the years in question. The figure offers a glimpse into the academic focus on evaluating Industry 5.0's preparedness and its influence on the economic expansion of SMEs in South Africa.

The line chart in 2018 shows the initial presence of one document, indicating a developing interest in the subject. This interest temporarily diminished in 2019 and 2020, as seen by the lack of documents throughout those years. Nevertheless, there was a significant rebound in 2021, producing a single document.

In 2022, there was a notable surge in research activity, as indicated by the line chart reaching its highest point with five documents. This surge suggests an increased academic emphasis and a rising acknowledgement of the significance of preparing SMEs in the region for Industry 5.0, which is crucial for their economic growth.

As we transition to 2023, the number of documents has decreased noticeably to three. This decline might be ascribed to multiple sources, including the consolidation of existing research, a change in the research community's priorities or the indication that the research has reached a degree of maturity with significant questions being addressed by the existing body of literature.

In general, the line chart illustrates a time of low activity in the beginning, a temporary halt in production and a subsequent rise that reaches a peak level of productivity in 2022, followed by a slight decline in 2023. This trend indicates an increasing scholarly interest and a developing comprehension of the role of Industry 5.0 in the economic expansion of SMEs in South Africa. This interest reaches its highest point before transitioning into a more stable phase of sustained but slower output. These changes may also indicate the broader economic or technological patterns affecting the region and the worldwide discussion surrounding Industry 5.0.

The information shown in Table 1 provides a concise overview of essential discoveries from multiple academic articles regarding the preparedness for Industry 5.0 and its impact on the economic development of SMEs in South Africa. The table is divided into six columns: Article, Challenges, Opportunities, Factors Influencing Industry 5.0, Industry 5.0 Technologies and Implications of Industry 5.0.

The articles highlight various obstacles SMEs encounter throughout the shift towards Industry 5.0. The factors encompassed in this list are financial limitations, industry-specific rates of acceptance, deficiencies in infrastructure,

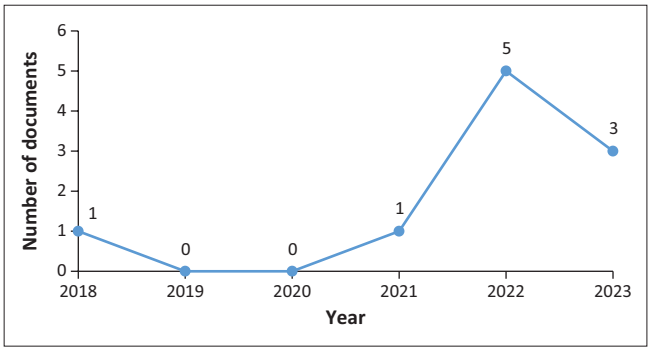


FIGURE 2: Document by year.

TABLE 1: Summary of key findings from selected articles on Industry 5.0 readiness and its impact on small and medium enterprises.

Article	Challenges	Opportunities	Factors influencing industry 5.0	Industry 5.0 technologies	Implications of industry 5.0
Ada et al. (2023)	Financial constraints, sector-specific adoption pace	Enhanced productivity, innovation potential	Technological adoption, workforce capabilities	AI, IoT, robotics	Increased competitiveness and innovation drive
Parvand and Rasiah (2022)	Infrastructure deficits, access to capital	Operational efficiency, cost savings	Financial support, infrastructure readiness	Big data, AI	Productivity improvement, cost reduction
Dwivedi et al. (2022)	Environmental compliance, high initial costs	Market positioning, customer satisfaction	Sustainability initiatives, consumer demand	Green technologies, AI	Enhanced market positioning, ecological benefits
Huang and Ichikohji (2023)	Skill gaps, integration complexity	Job satisfaction, operational efficiency	Human-centric technologies, collaborative robots	Collaborative robots, IoT	Operational efficiency, job satisfaction
Sartal, Llach and León-Mateos (2022)	Workforce training needs, financial barriers	Increased employability, innovation capacity	Training programs, digital skills	AI, digital platforms	Enhanced employability, innovation promotion
Ullah, Sepasgozar and Wang (2018)	Digital infrastructure inadequacies, regulatory hurdles	Improved connectivity, regulatory support	Infrastructure investments, policy frameworks	IoT, data analytics	Improved connectivity, regulatory compliance
Espinoza Pérez and Vásquez (2023)	Sustainability adoption barriers, technological complexity	Sustainable practices, competitive advantage	Environmental regulations, technology integration	Sustainable technologies, AI	Sustainability integration, market competitiveness
Vacchi et al. (2021)	Financial limitations, digital skill shortages	Productivity gains, global competitiveness	Government incentives, skill development	AI, advanced manufacturing	Economic growth, global market positioning
Opoku and Song (2023)	Educational gaps, sectoral variations	Skill development, educational advancements	Educational initiatives, industry partnerships	Digital skills, IoT	Skill enhancement, sectoral development
Bakon et al. (2022)	Funding access, infrastructure development	Economic growth, market expansion	Policy support, financial mechanisms	Big data, IoT	Economic development, market growth

Note: Please see the full reference list of this article, Takawira, B. & Pooe, D., 2025, 'SME readiness for Industry 5.0: A systematic literature review', *Southern African Journal of Entrepreneurship and Small Business Management* 17(1), a946. https://doi.org/10.4102/sajesbm.v17i1.946, for more information.

AI, artificial intelligence; IoT, Internet of Things.

obligations for environmental compliance, shortages in skills and technological intricacies. Financial obstacles are frequently acknowledged, indicating the substantial resources required to deploy sophisticated technologies. Moreover, disparities among sectors and education suggest that the preparedness for Industry 5.0 differs among various industries and is affected by the existing level of labour proficiency.

Although there are difficulties, Industry 5.0 offers significant opportunities for improving productivity, innovation potential, operational efficiency, cost reductions, market positioning and customer satisfaction. Some articles highlight Industry 5.0's capacity to promote sustainable practices and gain competitive benefits, emphasising the importance of green technologies.

Various elements, including the necessity for technical implementation, workforce proficiency, financial backing, infrastructural preparedness and sustainability endeavours, influence the adoption of Industry 5.0. Human-centric technology, collaborative robotics and customer demand are all essential factors (Zafar et al. 2024). Government incentives and educational programmes are crucial in tackling skill shortages and educational inequality.

The technologies linked to Industry 5.0 play a crucial role in realising the potential and surmounting the obstacles. Artificial intelligence, the IoT, robotics, big data, green technologies, digital platforms and data analytics have been recognised as the key technologies that propel Industry 5.0. These technologies are perceived as facilitators of enhanced competitiveness, innovation, operational efficiency and sustainable practices.

The implications of Industry 5.0 readiness for SMEs in South Africa are predominantly favourable. This includes expected benefits such as heightened competitiveness, a push for innovation, higher productivity, reduced costs, enhanced employability, better connection and adherence to regulatory requirements. The papers propose that adopting Industry 5.0 has the potential to result in substantial economic expansion and enhanced global market positioning for SMEs in South Africa.

Hence, the existing corpus of research suggests an intricate interaction of difficulties and possibilities linked to Industry 5.0 for SMEs in South Africa. Although there are significant financial and infrastructural constraints and worker training requirements, the potential for technical improvement and economic growth is considerable. Numerous aspects influence the industry's preparedness for Industry 5.0, and the use of appropriate technologies could have extensive and beneficial ramifications for the industry. Table 1 presents a succinct summary of key findings from several scholarly works concerning the readiness for Industry 5.0 and its influence on the economic advancement of SMEs in South Africa.

Themes and patterns

The literature on Industry 5.0 readiness and its impact on SMEs in South Africa has been analysed thematically, uncovering various significant themes and trends. These themes encompass the crucial domains in which Industry 5.0 impacts SMEs and the diverse difficulties and possibilities that emerge in this framework.

Technological adoption and integration

A meaningful subject that stands out is the incorporation and assimilation of cutting-edge technologies in SMEs. Industry 5.0 integrates AI, IoT, robotics and big data analytics into business operations. Research suggests that although several SMEs in South Africa are making progress in

embracing these technologies, the general adoption rate varies and is influenced by the specific industry. High-tech businesses exhibit greater adoption than traditional industrial sectors (Lee, Falahat & Sia 2021). This subject emphasises the necessity of improved support systems to assist technology integration across several sectors.

Human-centric approach

Industry 5.0 is characterised by its focus on human-centred principles, aiming to integrate human creativity and problem-solving skills with cutting-edge technology. The literature emphasises that this strategy is crucial in improving productivity and fostering creativity. The essential aspect in fully harnessing the capabilities of Industry 5.0 is the cooperative engagement between humans and machines, typically assisted by the use of 'cobots' (collaborative robots) (Zafar et al. 2024). This subject highlights the importance of cultivating a workforce with expertise in technical and artistic domains.

Sustainability and environmental impact

Environmental sustainability is a fundamental element of Industry 5.0, emphasising adopting environmentally friendly methods. Implementing environmentally friendly technologies and sustainable manufacturing methods is increasingly advantageous and essential for long-term economic sustainability. Small and medium enterprises that have incorporated sustainable practices have reported improved market positioning and higher levels of customer satisfaction, according to Bacinello et al. (2021). This pattern suggests an increasing inclination towards sustainability and its significance in the competitive environment.

Economic benefits and growth

Another crucial topic is the economic influence of Industry 5.0 on SMEs. The literature regularly shows that adopting Industry 5.0 technology substantially improves productivity, cost savings and enhanced innovation capabilities (Vrontis et al. 2022). These advantages improve competitiveness and market expansion prospects, contributing to overall economic growth. However, many existing obstacles must be overcome to achieve these advantages fully.

Challenges in implementation

Multiple studies emphasise the difficulties that SMEs encounter when it comes to adopting Industry 5.0 technologies. Financial limitations are commonly cited as a significant obstacle for many SMEs who do not possess the necessary funds to invest in new technologies and infrastructure (Huang & Chen 2022). Moreover, the insufficiency of digital infrastructure, especially in rural regions, presents substantial obstacles to the successful integration of technology (Garzoni et al. 2020). This subject emphasises the need for specific financial and infrastructural assistance to shift towards Industry 5.0.

In South Africa, SMEs face distinct obstacles to adopting Industry 5.0 technologies, with research indicating that financial constraints, inadequate digital infrastructure and a paucity of skills are the major hindrances (Hasani et al. 2023). These challenges are especially evident for SMEs in sectors characterised by low digitalisation, such as traditional manufacturing and retail, where financial assistance and technical assistance frequently fall short of the demands necessary for the adoption of advanced digital technologies (Loury-Okoumba & Mafini 2021; Maisiri & Dyk 2019).

Skill development and training

The literature frequently addresses the issue of a disparity in skills among the workforce. To effectively execute Industry 5.0, a workforce with expertise in digital skills and sophisticated manufacturing procedures is necessary. The existing educational and training programmes frequently fail to fulfil this demand adequately (Hanafiah et al. 2020). This pattern highlights the need for extensive training and reskilling programmes to adequately prepare the workforce for Industry 5.0.

Policy and regulatory environment

Government policy and regulation have a crucial influence in this context. As stated by Fatoki (2021), policy frameworks that effectively provide incentives for using technology and offer support to SMEs are essential for the successful implementation of Industry 5.0. The literature indicates that although existing laws offer some assistance, more resilient and flexible regulatory frameworks that can effectively address swift technological progress are required.

Analysing these themes and patterns offers a thorough comprehension of Industry 5.0's preparedness and influence on SMEs in South Africa. They emphasise the crucial areas that require attention and assistance to ensure that SMEs can effectively adapt to and take advantage of Industry 5.0's breakthroughs.

Discussion

These findings underscore that SMEs in South Africa encounter unique industry challenges relative to their counterparts in more digitally advanced economies. Despite the potential for enhanced productivity and market competitiveness, these organisations face difficulties in allocating resources to digital infrastructure, training and sustainable practices (Garzoni et al. 2020; Madzimure et al. 2020). In South Africa, inadequate public sector assistance and the uneven allocation of digital resources among regions have created an inequitable environment for SMEs, especially in rural or historically marginalised areas (Fatoki 2021). Implementing legislative interventions and industry-specific training programmes could significantly improve SME Industry 5.0 preparedness and economic influence (Maisiri & Dyk 2019; Venter & Hayidakis 2021).

Small and medium-sized enterprises in South Africa encounter unique obstacles in the adoption of Industry 5.0 technologies, including restricted capital access, inadequate digital infrastructure and a deficiency of skilled personnel that impede the integration of advanced technologies such as collaborative robotics and artificial intelligence (Hanafiah et al. 2020; Madzimure et al. 2020). It is crucial to address these obstacles, as research indicates that SMEs possessing sufficient digital resources and proficient personnel are more competitive and adaptive in a swiftly evolving business landscape (Vrontis et al. 2022). Moreover, financial limitations may restrict SMEs' capacity to invest in technology, highlighting the need for targeted finance initiatives and governmental support to foster an environment suitable for Industry 5.0 adoption (Hasani et al. 2023). Consequently, cultivating Industry 5.0 preparedness in South Africa necessitates a comprehensive strategy that tackles these particular difficulties to enhance SMEs' long-term growth and competitiveness.

Small and medium enterprises need to adopt advanced technologies like AI, IoT and robots to improve productivity and stay ahead of the competition. Recent research indicates that SMEs in South Africa are increasingly adopting these technologies, although the rate of adoption varies across different sectors (Bracci et al. 2021; Mafini & Loury-Okoumba 2018). The emphasis on diversity emphasises the significance of establishing industry-specific solutions to promote the incorporation of technology (Jere & Ngidi 2020; Loury-Okoumba & Mafini 2021). The results align with previous research that highlights the substantial influence of Industry 5.0 technologies in enhancing industrial efficiency and promoting innovation (Madzimure et al. 2020; Mathu 2019).

Industry 5.0 places great importance on human creativity and problem-solving abilities in the manufacturing process (Agyabeng-Mensah et al. 2022; Karuppiah et al. 2022). The incorporation of collaborative robots (cobots) operating in conjunction with human employees signifies a significant progression in this regard (Belitski & Liversage 2019; Jere & Ngidi 2020). The collaborative approach improves operational efficiency and work satisfaction and promotes creativity (Chung & Kim 2023; Shumba 2024). These findings align with global trends that promote the mutually advantageous interaction between humans and robots in the context of the imminent industrial revolution.

Sustainability and environmental effects are vital considerations in Industry 5.0, particularly for SMEs aiming to enhance their market position. The studies were conducted by Yacob, Wong and Khor (2019) and Ghobakhloo et al. (2022). The transition to green technologies aligns with customer desires for environmentally conscious products and activities (Alraja et al. 2022; Maesaroh 2024). The current body of literature extensively discusses the shift towards sustainability, highlighting cost reduction benefits and improved brand image (Chau 2024; Wen et al. 2019). These observations are consistent with the worldwide pattern highlighting the importance of sustainable practices and environmental responsibility in Industry 5.0.

Small and medium enterprises stand to gain significant economic advantages from the implementation of Industry 5.0. Significant economic growth prospects can arise from increased productivity, cost savings and greater innovation capabilities (Al-Khatib 2023; Imran et al. 2019). Studies provide evidence that SMEs can improve their competitiveness in the global market by adopting Industry 5.0 technologies (Arshad & Arshad 2019; Jalali, Abhari & Jaafar 2022). Nevertheless, to effectively capitalise on these benefits, it is imperative to confront the current barriers and difficulties (Kurdve, Bird & Laage-Hellman 2020; Tian et al. 2023). Small and medium enterprises must overcome these obstacles to take advantage of the economic advantages of Industry 5.0 technology.

Adopting Industry 5.0 technologies encounters substantial obstacles, mostly from budgetary limitations and insufficient digital infrastructure. These challenges align with previous studies, highlighting the restricted availability of funds and inadequate infrastructure as significant barriers to technological advancement in developing nations. The studies were conducted by Müller, Kiel and Voigt (2018) and Ghadge et al. (2020). In addition, the ongoing problem of skills gaps among workers presents a substantial obstacle, requiring significant training and skill development initiatives (Rajesh 2023; Vasantha 2023). Supportive policies and adaptable regulatory frameworks facilitate the transition to Industry 5.0. The findings underscore the significance of government initiatives that offer monetary incentives, foster infrastructural development and deliver educational programmes to bolster SMEs (Chen et al. 2021; Samani & Saghafi 2023). It aligns with previous studies that recommend a cooperative strategy engaging policymakers, industry executives and educational institutions to promote the use of technology (Abu-Rumman et al. 2023; Grida, Elrahman & Eldrandaly 2022).

The preparedness for Industry 5.0 has considerable ramifications for economic expansion, particularly in developing nations such as South Africa, where small and medium-sized enterprises are pivotal to employment and GDP contributions (Fatoki 2021). South African SMEs may enhance productivity, decrease operating expenses and bolster competitiveness in local and global markets by implementing Industry 5.0 technologies, including collaborative robotics, AI and IoT (Vrontis et al. 2022). The distinctive socio-economic circumstances in South Africa, such as restricted access to money, a deficiency of skills and infrastructural inadequacies, impede the swift implementation of these technologies (Hanafiah et al. 2020). Mitigating these obstacles via specific policies that allocate financing, enhance skills training and upgrade infrastructure could empower South African SMEs to capitalise on Industry 5.0 for sustained economic advancement (Madzimure et al. 2020). Consequently, Industry 5.0 preparedness in South Africa encompasses technological integration and establishing a supportive ecosystem that promotes resilience and economic progress.

Implications for small and medium enterprises and economic growth in South Africa

The consequences of SMEs' preparation for Industry 5.0 and its impact on economic growth in South Africa are significant and diverse. By combining cutting-edge technologies with a focus on human needs, Industry 5.0 can significantly enhance productivity, creativity and sustainability, thus contributing to the country's overall economic growth.

To effectively capitalise on the advantages of Industry 5.0, SMEs must improve their technological adoption. Investing in advanced technology and creating strategies tailored to individual industries are essential to effectively tackle the distinct requirements and issues encountered by different sectors (Quaye & Mensah 2019). Prior research highlights the significance of technological innovation in enhancing the competitiveness of SMEs. According to Quaye and Mensah (2019), SMEs can significantly enhance their productivity and efficiency by incorporating advanced manufacturing technologies. Marrucci, Rialti and Balzano (2023) emphasised that adopting technology plays a crucial role in promoting industrial growth and improving competitiveness. It is supported by Marrucci et al. (2023) and Müller (2024). Policymakers are crucial in assisting the shift to Industry 5.0 by allocating financial resources and providing incentives to promote technology investments. Limited financial resources might substantially hinder adopting technology (Jalali et al. 2022; Oduro 2019). The involvement of politicians, industry leaders and educational institutions in collaborative initiatives is essential for promoting the use of technology and fostering innovation in SMEs (Jalil, Ali & Kamarulzaman 2021).

To adhere to Industry 5.0's human-focused principles, it is crucial to prioritise improving the workforce's digital skills and creative capabilities. Training programmes and educational activities are essential for equipping individuals with the skills to navigate advanced technology proficiently. The literature continually emphasises the significance of staff development in effectively adopting Industry 5.0. Román, Rodriǵuez and Jaramillo (2018) conducted the study. Jerbić and Švaco (2023) investigate the capacity of human-centric technologies to augment job happiness and stimulate innovation by integrating human creativity with machine precision. Moreover, Saptaningtyas and Rahayu (2020) contended that allocating resources towards worker training is crucial.

To take advantage of the sustainability emphasis in Industry 5.0, SMEs can improve their market position and fulfil consumer demands for environmentally friendly products. By adopting environmentally friendly technologies and sustainable practices, SMEs can generate cost savings and enhance their brand image, promoting long-term economic sustainability. Ghobakhloo et al. (2021) highlighted the advantages of sustainability, such as lowering costs and improving market competitiveness. In addition, the growing significance of sustainable practices for SMEs distinguishes themselves in the global market (Alraja et al. 2022).

Small and medium enterprises can see significant economic expansion by efficiently adopting Industry 5.0 technologies. The total economic advancement of South Africa will be positively influenced by increased productivity, innovation and competitiveness. Small and medium enterprises can enhance productivity, innovation and competitiveness by overcoming challenges and taking advantage of the opportunities offered by Industry 5.0. Therefore, it contributes to the economic growth of the country (Hoe et al. 2022). Zarbà et al. (2022) highlighted the notable influence of Industry 5.0 in enhancing industrial efficiency and economic performance. In addition, the broader economic advantages of embracing technology, such as creating jobs and stimulating economic activity, have been emphasised (Qiong & Hanafiah 2023).

This study offers useful information regarding the preparedness and consequences of Industry 5.0 on SMEs in South Africa. By overcoming challenges and taking advantage of opportunities in Industry 5.0, SMEs in South Africa may boost their productivity, innovation and competitiveness, ultimately contributing to the country's economic progress. These findings highlight the significance of a cooperative approach that includes policymakers, industry executives and educational institutions to encourage technology adoption and stimulate economic growth.

Policy and practice recommendations

A comprehensive strategy addressing their financial, infrastructural, educational and regulatory challenges is imperative to equip SMEs in South Africa for Industry 5.0 adequately. The study's findings offer numerous suggestions for policies and practices that can assist SMEs in adopting new technologies and sustainable practices. Consult the schematic labelled Figure 2.

Increasing the accessibility of financial resources is crucial for SMEs to allocate cash towards adopting Industry 5.0 technologies. The financial burden on SMEs can be alleviated by implementing dedicated funding schemes and financial instruments, such as low-interest loans, grants and subsidies. Moreover, the implementation of tax incentives and subsidies for investments in advanced technologies and eco-friendly practices might operate as an extra motivation for SMEs to adopt Industry 5.0 advancements. Financial aid schemes are essential in helping SMEs overcome their restricted access to funding. Consequently, this enables businesses to make crucial expenditures in technical enhancements.

Education and training are crucial components for adequately preparing for Industry 5.0. Developing comprehensive training programmes that primarily focus on digital skills and advanced manufacturing methods can provide the workforce with the necessary capabilities to operate and innovate proficiently with new technology. Establishing collaborations with universities, technical colleges and other educational institutions is essential

for integrating Industry 5.0 concepts into curricula and research endeavours. Facilitating partnerships between industry and academics can foster research and development endeavours, nurturing a skilled workforce that is well prepared to fulfil the demands of Industry 5.0.

A robust legal and policy framework is crucial for facilitating the transition to Industry 5.0. Developing adaptable regulatory frameworks that can accommodate emerging technologies and ensure proactive policies can help SMEs navigate the constantly evolving technology landscape. Government actions, such as providing financial incentives, building infrastructure and implementing educational programmes, are essential in supporting SMEs in their technical endeavours. By implementing sustainability standards and providing incentives for the use of environmentally friendly technologies, SMEs can be effectively motivated to integrate sustainable practices into their business models, aligning with the goals of Industry 5.0.

Therefore, facilitating networking and collaboration among SMEs can enhance knowledge sharing, stimulate innovation and enhance competitiveness. Facilitating the creation of industrial networks and clusters can foster collaboration and allow SMEs to acquire valuable resources and knowledge. Establishing innovation hubs and incubators with state-of-the-art resources, expert guidance and financial opportunities can serve as centres of excellence for Industry 5.0 technologies. These facilities provide a favourable environment for SMEs to test and thrive, accelerating their advancement in creating and implementing cutting-edge technology.

In order to enhance the readiness of SMEs in South Africa for Industry 5.0, it is imperative to develop a comprehensive strategy that addresses the financial, infrastructural, educational and regulatory challenges they face. Stakeholders may help SMEs transition to Industry 5.0 by implementing these policy and practice suggestions. Consequently, this will lead to a notable enhancement in productivity, innovation and sustained economic growth. These initiatives will ensure that SMEs are strategically positioned to compete in the global market and make a significant contribution to the overall economic progress of South Africa. An extensive approach to tackle their financial, infrastructural, educational, and regulatory difficulties is essential to fully prepare SMEs in South Africa for Industry 5.0. The study's findings provide some recommendations for policies and practices that can aid SMEs in the adoption of new technology and sustainable practices (Figure 3).

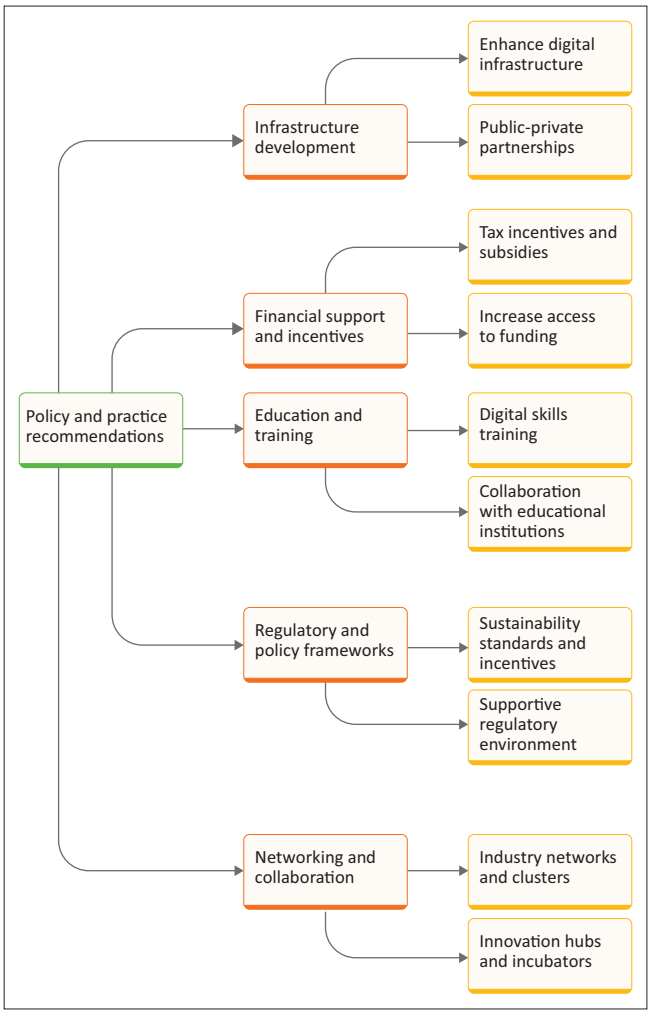


FIGURE 3: Policy and practice recommendations.

Limitations and suggestions for future research

This study investigates the readiness of SMEs in South Africa for Industry 5.0 and its economic implications, encompassing various limitations. The variety of data sources and the variations among SMEs in different industries can affect the relevance of the findings. In addition, the rapid advancement of Industry 5.0 technologies suggests that the study's conclusions may quickly become outdated as new advancements emerge. Utilising prior literature and secondary data can introduce biases, limiting the analysis's overall comprehensiveness. To acquire more dependable and up-to-date information regarding the preparedness of SMEs for Industry 5.0 and its consequences, future research should incorporate longitudinal studies and gather primary data. The report emphasises the importance of being ready for Industry 5.0 to promote economic expansion among SMEs in South Africa. Further enquiries should focus on approaches particular to the industry, the impact of training programmes on the workforce's skills and the supportive role of government policies in encouraging technology usage. Moreover, assessing the long-lasting economic and environmental impacts of implementing Industry 5.0 can provide valuable knowledge on sustainable development. Developing comprehensive frameworks tailored to the South African context to assess the readiness of SMEs for Industry 5.0 will further enhance their efforts to undertake digital transformation. Future research endeavours can enhance understanding and facilitate the success of SMEs in adapting to the evolving industrial landscape by concentrating on these particular domains.

Managerial implications

Managers of SMEs in South Africa should prioritise the adoption of Industry 5.0 technologies to enhance productivity and competitiveness. It involves allocating resources towards investments in AI and the IoT and tailoring these technologies to suit the unique needs of their businesses. Furthermore, managers must prioritise enhancing the digital skills of their employees by implementing comprehensive training programmes. It will enable them to utilise cutting-edge technologies effectively. Emphasising sustainable actions can further improve market positioning and consumer happiness. In order to enable their SMEs to use the benefits of Industry 5.0 fully, managers need to prioritise tackling budgetary constraints and advocating for improved digital infrastructure. By using these strategies, managers have the potential to create significant economic growth and foster creativity within their businesses.

Conclusion

The research indicates that the preparedness for Industry 5.0 among South African SMEs is influenced by systemic obstacles, such as insufficient financial resources, a shortage of skilled labour and deficient digital infrastructure (Hanafiah et al. 2020). Implementing tailored policies and support mechanisms could enhance the competitiveness of SMEs in the digital economy. Policies emphasising digital inclusion, infrastructure improvement and industry-specific skills training could enable South African SMEs to use the productivity and sustainability benefits presented by Industry 5.0 (Fatoki 2021; Hasani et al. 2023). Subsequent research should persist in examining these localised impediments and remedies to enhance support for South Africa's SME environment in conforming to Industry 5.0 prerequisites.

The study has made significant findings about the readiness of SMEs in South Africa for Industry 5.0 and its economic implications. Small and medium enterprises are increasingly adopting technologies such as AI and the IoT. Nevertheless, the adoption percentage varies between industries, highlighting the significance of creating customised methods for each specific business. The preparedness of a workforce is significantly impacted by their competencies, underscoring the necessity for comprehensive training in digital skills and contemporary industrial protocols. Furthermore, SMEs that adopt sustainable practices are better positioned to take advantage of the benefits of Industry 5.0. That leads to improved market positioning and higher levels of customer satisfaction. The economic advantages include increased productivity, decreased costs and enhanced innovation, all of which strengthen the competitiveness of SMEs and contribute to economic growth. However, the advantages of these progressions are impeded by issues such as a lack of financial resources, insufficient digital infrastructure and shortages in skills. In order to effectively maximise the advantages of Industry 5.0, SMEs must address these challenges.

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Competing interests

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Authors' contributions

B.T. conceptualised and drafted the manuscript. D.P. supervised, corrected and edited the manuscript.

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Data availability

The data that support the findings of this study are available from the corresponding author, D.P., upon reasonable request.

Disclaimer

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