

The Integration of Artificial Intelligence Solutions to Bridge Occupational Health and Safety (OHS) Compliance Gaps in South African Small and Medium Enterprises (SMEs)

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Abstract

South African small and medium-sized enterprises (SMEs) face considerable challenges in complying with Occupational Health and Safety regulatory requirements, mainly due to limited resources, deficient safety management systems, and inadequate monitoring practices. The integration of Artificial Intelligence offers substantial potential to enhance safety performance through predictive analytics, automated hazard detection, and digital compliance tools. However, empirical studies examining AI's incorporation into OHS compliance within South African SMEs remain limited. Employing a literature-based methodology, this review analyzes OHS compliance challenges confronting SMEs and explores AI applications to address these gaps. It proposes strategies for embedding AI solutions into prevailing OHS frameworks and identifies viable AI approaches to bolster compliance among South African SMEs. The analysis reveals that AI applications present significant opportunities for advancing OHS compliance in this context. By synthesizing extant knowledge, this review establishes a basis for informed decision-making and subsequent research at the confluence of AI and OHS.

Keywords

Artificial Intelligence (AI), AI Applications, Occupational Health & Safety (OHS), Small Medium Enterprises (SMEs) and Compliance Gaps

1. Introduction

Small and medium-sized enterprises play a pivotal role in driving national economic development and employment generation. In contrast to larger corporations, SMEs exhibit distinct advantages, such as operational independence and agility, which enable them to respond swiftly to dynamic market demands. Over time, upon establishing their market presence, SMEs can evolve into larger organisations, achieving higher financial turnover, expanding their workforce, and scaling production capacities. Nonetheless, these enterprises confront numerous challenges that obstruct their growth, including the effective management of occupational health and safety (Ji et al., 2022). Although SMEs in

South Africa are not always formally registered or regulated, they remain legally obligated to comply with the Occupational Health and Safety Act No. 85 of 1993. The incidence of workplace accidents in the country attributable to inadequate adherence to relevant health and safety regulations is alarmingly high, adversely affecting the state, employers, and employees alike (Esterhuyzen, 2019). Research indicates that South African SMEs face substantial challenges in complying with the Occupational Health and Safety Act No. 85 of 1993, stemming from multiple factors including inadequate regular inspections and audits, deficient management practices, insufficient supervision, shortages of materials and components, lack of management commitment, unavailability of necessary equipment and tools, poor communication among workers, limited employer involvement, and insufficient training and risk education (Mashwama et al., 2018; Esterhuyzen, 2019). These challenges constitute the primary impediments to effective occupational health and safety implementation in small and medium-sized enterprises. Artificial intelligence is revolutionizing the workplace by reshaping business operations and the nature of employees' roles. This technology is poised to exert a profound influence on the global economy through transformations in the labor market and the fundamental character of work (Downie and Hayes, 2022). Although the integration of artificial intelligence into occupational health and safety remains nascent, it encompasses diverse workplace applications. These applications confer substantial benefits on worker health and safety, including continuous monitoring of personnel well-being and the work environment via wearable devices and sensors (El-Helaly, 2024). Therefore, the incorporation of artificial intelligence offers considerable potential for improving the efficacy of occupational health and safety management (Chadyiwa, 2024). This study seeks to explore the integration of artificial intelligence applications to address occupational health and safety compliance gaps in South African small and medium-sized enterprises.

1.1 Objectives

This research investigates the incorporation of artificial intelligence applications to address Occupational Health and Safety compliance deficiencies in South African small and medium-sized enterprises. The primary objectives are delineated below. These include: (1) To conduct a comprehensive review of the literature to identify and analyse current OHS compliance gaps faced by South African SMEs; (2) To explore how AI-driven solutions can effectively mitigate these identified compliance gaps within the unique operational contexts of South African SMEs (Adikwu et al., 2024; Fiegler-Rudol et al., 2025). To evaluate the practical implications and potential challenges associated with implementing AI-based OHS solutions in South African SMEs; and (4) To identify key factors influencing the adoption of AI technologies in enhancing OHS management within these enterprises (Acheampong et al., 2025).

- 1.1.1 Examine the challenges and barriers impeding the adoption of AI-based OHS solutions within SMEs.
- 1.1.2 Identify and elucidate gaps in the extant literature concerning the role of AI technologies in supporting OHS compliance among South African SMEs.
- 1.1.3 Offer practical recommendations for South African SMEs, policymakers, and relevant stakeholders, drawing from the literature review findings to guide strategic decision-making for the effective and sustainable integration of AI applications in OHS management.

2. Methods

This study adopted a literature-based methodology to investigate Occupational Health and Safety (OHS) compliance challenges faced by small and medium-sized enterprises (SMEs) and to evaluate artificial intelligence (AI) applications capable of addressing these compliance gaps. This approach aims to deliver valuable insights into the integration of AI solutions for mitigating OHS compliance deficiencies among South African SMEs. The methodology comprised the following key steps:

- **Formulation of Research Objectives:** The research commenced with the establishment of clearly defined objectives to explore the integration of AI solutions for bridging OHS compliance gaps in South African SMEs. These objectives encompassed identifying existing AI applications, assessing their benefits, and pinpointing relevant gaps within the SME context.
- **Literature Review and Data Collection:** A systematic review of academic databases, peer-reviewed journals, conference proceedings, and industry reports was undertaken to gather pertinent literature on AI applications and OHS compliance gaps in the South African SME sector. Sources were identified via targeted searches employing keywords such as "artificial intelligence applications," "AI in OHS," "SMEs," "OHS compliance gaps," and "AI for bridging OHS compliance gaps."
- **Inclusion and Exclusion Criteria:** Literature selection for studies on "AI applications to bridge OHS compliance gaps" 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.

- **Screening and Selection:** Initial screening involved evaluating titles and abstracts for alignment with the research objectives, followed by comprehensive full-text reviews to confirm suitability for inclusion.
- **Data Extraction and Synthesis:** Key data were extracted from selected sources, capturing details on AI applications in OHS—such as compliance gaps, identified frameworks, their components, and applicability to SMEs. This information was subsequently organized and synthesized to construct a holistic overview of AI integration frameworks for OHS compliance.
- **Data Analysis and Categorization:** The extracted data underwent thematic analysis to categorize research gaps, prevalent AI applications in OHS, and the benefits of AI integration. This process evaluated their strengths, limitations, and suitability within the South African SME context, emphasizing key differences and commonalities to inform insights on effectively bridging compliance gaps through AI. This systematic approach ensured a robust foundation for understanding the potential of AI to enhance OHS outcomes in this specific economic sector.

3. Literature Review

This study aims to reveal strategies and methodologies for integrating artificial intelligence applications to bridge Occupational Health and Safety compliance gaps. The primary objectives are delineated as follows: to conduct a comprehensive literature review identifying and analysing extant OHS compliance gaps among South African small and medium-sized enterprises; to examine the challenges and barriers impeding the adoption of AI-based OHS solutions within SMEs; and to identify and elucidate gaps in the prevailing literature on the role of AI technologies in bolstering OHS compliance for South African SMEs, encompassing an in-depth exploration of pertinent frameworks employed across diverse contexts. Furthermore, this comprehensive review aims to offer practical recommendations for South African SMEs, policymakers, and relevant stakeholders, derived from the literature findings, to guide strategic decision-making for the effective and sustainable integration of AI applications in OHS management (Akano et al., 2024).

3.1 OHS compliance challenges amongst South African SME's

According to Esterhuyzen (2019) enterprises of all sizes must demonstrate an unwavering commitment to compliance and enforcement. Nevertheless, small businesses encounter distinct challenges in occupational health and safety management. These challenges encompass limited resources, insufficient guidance, absence of holistic integration of OHS into core business operations, inadequate training opportunities, underdeveloped OHS competencies, and limited employer-employee cooperation. The literature further identifies supervisor negligence or shortages of skilled supervisors as barriers to OHS directive compliance. Small business owners and managers often lack requisite knowledge, experience, attitudes, or motivation toward OHS, thereby constituting additional compliance impediments. Impracticable, unrealistic, excessively time-consuming, or overly numerous regulations may foster rule-bound behaviors at the expense of safe practices, further obstructing compliance. Moreover, individual and organizational factors impede OHS adherence; individual elements include deficient planning, self-image concerns, and status issues, while organizational factors involve oversight and time pressures. These challenges are intensified by group dynamics, such as prioritizing production over OHS, disregarding safety risks, and misapplying effective work rules. Financial constraints, lack of leadership commitment, and insufficient institutional support also present significant barriers to effective OHS compliance, particularly within the university sector, which shares analogous challenges with SMEs (Mtikitiki et al., 2025).

3.2 AI Adoption Challenges amongst South African SMEs.

Artificial Intelligence has attracted substantial scholarly and practical interest over the past decade, propelled by breakthroughs in computational processing capabilities, cloud infrastructure, and deep learning paradigms. Exemplars of this proliferation include chatbots, sophisticated demand forecasting models, and autonomous vehicles, which are increasingly embedded across industries. Mohib et al., (2025) observed that AI can augment organizational efficiency by up to 40%, positioning it as essential for global competitiveness. Nonetheless, South African small and medium-sized enterprises encounter formidable barriers to AI adoption, including resource limitations, restricted access to advanced technologies, exigencies of adapting to a dynamic business milieu, and skills shortages. These impediments undermine SME productivity and competitiveness domestically, while also obstructing the deployment of AI-driven solutions to redress occupational health and safety compliance deficits. Pertinent challenges include:

Financial Constraints

Not It is unsurprising that the predominant concern for SMEs regarding AI implementation revolves around cost. Numerous facets of AI necessitate substantial expenditures, including software licenses, specialized hardware, and highly skilled personnel. Operating within constrained budgets, SMEs encounter significant difficulties in deploying these costly technologies. As observed, whereas large enterprises can allocate funds for AI experimentation and mitigate resultant losses, SMEs lack such financial resilience (Mohib et al., 2025). Moreover, the ongoing expenses associated with technology maintenance, upgrades, and scalability further deter AI integration into business operations. These fiscal impediments underscore the imperative for developing cost-effective AI solutions tailored specifically for SMEs.

Limited Technical Expertise

The deployment of AI technologies demands proficiency in data science, machine learning, software engineering, and cognate disciplines. A primary obstacle is the dearth of internal expertise within SMEs to implement and sustain these systems effectively. According to Mohib et al., (2025) SME's face challenges in attracting and retaining specialized talent, due to constrained limited budgets and organizational scale compared to larger firms. Additionally, prevailing training programs often fail to accommodate the unique contexts of SMEs, rendering many employees ill-equipped to comprehend or utilize AI tools. This paucity of technical proficiency highlights critical deficiencies in skills development and necessitates enhanced collaborations between SMEs and higher education institutions (Mohib et al., 2025).

Data-Related Challenges

Mohib et al., (2025) reports that, notwithstanding advancements in AI, SMEs grapple with procuring, structuring, and sustaining high-quality data essential for AI functionality. In contrast to large corporations equipped with sophisticated data infrastructures, SMEs typically lack the requisite financial and human resources to establish robust information management systems. Compounding these issues are regulatory mandates, such as the GDPR, which SMEs often navigate inadequately. Data accessibility and quality are pivotal for training AI algorithms; their absence substantially curtails the viable implementation of AI.

Accessibility of AI Solutions

Mohib et al., (2025) further states that existing AI solutions in the marketplace predominantly target enterprise-scale organizations, rendering them unsuitable for SMEs. These solutions normally demand substantial resources and high implementation costs. Emphasising a need for efficient, economical AI tools customized to SME requirements. Bridging this resource gap may be achieved through public-private partnerships and governmental incentives to foster an AI-centric ecosystem.

3.3 Current AI application and Occupational Health and Safety (OHS) enhancement.

Artificial intelligence assumes a pivotal role across diverse facets of occupational processes, fundamentally transforming task execution and management. Employing computational algorithms to analyze and process data, AI facilitates targeted interventions that influence workforce dynamics. Key AI modalities include machine learning, deep learning, natural language processing, and rule-based expert systems (Shah and Mishra, 2024; Trivedi and Alqahtani, 2024). These technologies have permeated occupational health and safety, enabling scrutiny of both structured and unstructured datasets (Shah and Mishra, 2024; Trivedi and Alqahtani, 2024). Their applications encompass machinery and industrial process coordination, workforce administration, customer risk evaluation, benefits analysis, and employee safety assessment. To protect employees, employers may implement strategies recommended by the United States National Institute for Occupational Safety and Health, including hazard information and training provision, comprehensive safety programs, and supply of personal protective equipment. Despite such initiatives, human error remains a predominant factor in workplace accidents. AI addresses this limitation through its proficiency in rapidly processing and analyzing data to detect potential risks and hazards overlooked by human perception. Moreover, AI has introduced innovative approaches to work practices, such as technology-enabled employee performance evaluations (Shah and Mishra, 2024). This capacity for predictive analytics and real-time monitoring offers a significant paradigm shift from reactive safety measures to proactive hazard mitigation (El-Helaly, 2024). For instance, AI-driven risk assessments, automated hazard detection, and IoT-enabled real-time monitoring systems can enhance occupational health and safety compliance and offer cost-effective safety solutions, particularly for resource-constrained enterprises (Mixafenti et al., 2025). Furthermore, AI technologies offer the potential to address safety and productivity issues by removing personnel from hazardous environments and automating aspects of safety planning (Mustapha et al., 2024).

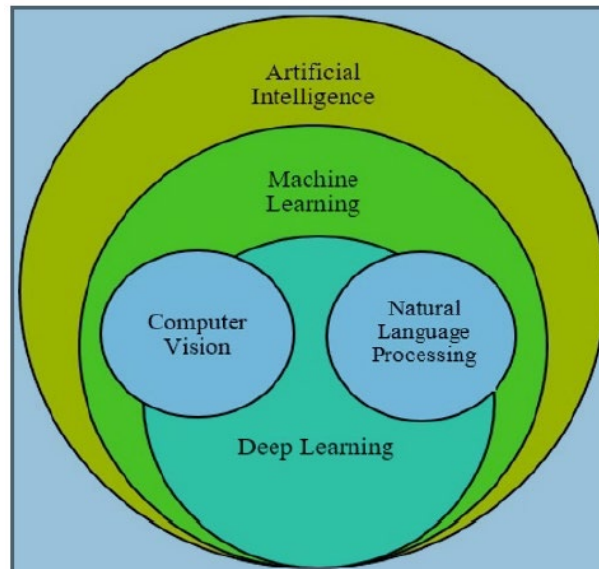


Figure 1. Progressing subcomponents of AI systems (Trivedi & Alqahtani, 2024)

Figure 1 illustrates the progressive subcomponents of AI systems (Trivedi and Alqahtani, 2024). It depicts the evolutionary integration of artificial intelligence into diverse applications through machine learning, computer vision, knowledge-based systems, and natural language processing. These AI paradigms provide unique capabilities and methodologies for data management and analysis, thereby facilitating informed decision-making.

Workplace safety and AI-enabled PPE

Given the paramount importance of worker safety given the high incidence of workplace accidents, it is imperative to modernize traditional tools and procedures to align with the contemporary technological paradigm. Recent scholarly investigations have examined the deployment of artificial intelligence within the manufacturing sector, fostering greater industry interconnectivity while augmenting worker safety and security. The emergence of intelligent personal protective equipment and wearable technologies enables the acquisition of data pertaining to personnel and their environment. This data-informed strategy possesses the capacity to diminish the occurrence of accidents and occupational illnesses, thereby affecting a substantial improvement in overall workplace conditions. Innovations in smart PPE facilitate the continuous monitoring of vital health parameters and the evaluation of industrial settings. Diverse methodologies are available for integrating wearables into occupational environments, permitting an analysis of how interconnected device networks can enhance individual protection (Shah and Mishra, 2024).

AI computer vision in monitoring and surveillance tools for workplace safety

Computer vision, powered by AI, demonstrates substantial potential for bolstering workplace safety through diverse applications. It supports functions such as observing employee behaviors, detecting latent hazards, and delivering instantaneous alerts. A salient illustration is the deployment of thermal imaging cameras to identify heat stress among workers, enabling employers to monitor body temperatures continuously and provide timely interventions, including respite periods or suitable PPE. Furthermore, computer vision plays a crucial role in surveillance systems, where AI-enhanced cameras trace worker movements, promptly identify risks like tripping obstacles or unstable machinery, and detect unauthorized access to restricted or perilous zones, thereby cultivating a safer operational milieu. The expansion of AI has resulted in a transformative shift, propelled by progress in data management, computer vision, and machine learning. This evolution manifests in the advent of innovative AI platforms addressing multifaceted requirements, encompassing data annotation, curation, object recognition, video analytics, classification, identification, and natural language processing (Shah and Mishra, 2024).

AI-based virtual reality for training employees

Virtual reality has established itself as an efficacious instrument for safety training, particularly in high-hazard sectors where experiential learning poses substantial risks. Furthermore, employers can leverage VR to impart practical proficiency and situational awareness in perilous scenarios, thereby equipping workers to avert incidents and mitigate the likelihood of fatalities and injuries through enhanced risk-prevention capabilities. This technology proves to be economical, targeted, and effective in accident mitigation by reducing human error. VR supplants conventional training modalities, such as slide presentations and video tutorials, with immersive and more retentive experiences. Sectors including chemicals, construction, mining, and defense have embraced VR-centric training initiatives owing to their cost-efficiency and capacity to reduce occupational injuries and casualties (Shah and Mishra, 2024).

3.4 Gaps in Current Literature

Despite increasing research on AI adoption among SMME's, there's a lack in coherence and consensus, resulting in critical gaps in current literature stipulated below:

- **Limited empirical evidence on AI adoption for OHS in South African SMEs:** There is limited empirical research exploring how AI can support Occupational Health and Safety (OHS) compliance in South African SMEs. Existing studies mainly address AI adoption challenges in SMEs generally such as inadequate infrastructure, financial constraints, and limited technical skills without examining how these issues relate specifically to OHS compliance. This leaves a gap in understanding how AI can realistically strengthen safety practices in SME environments. Research confirms that South African SMEs show slow and uneven AI adoption, but these studies do not focus on OHS compliance or workplace safety mechanisms. Additionally, broader studies on digitalisation in African OHS contexts highlight technological change and the need for modernization but do not provide SME-specific empirical data, reinforcing the gap.
- **Insufficient research on cost-effective AI-based OHS solutions for SMEs:** Another gap arises from the lack of affordable, SME-tailored AI solutions designed to meet OHS compliance needs. Most available AI OHS tools such as advanced predictive systems, machine learning hazard detectors, and wearable technologies are expensive and built for large enterprises. Literature shows that SMEs face cost, infrastructure, and skill limitations that restrict their ability to adopt sophisticated technologies, yet researchers have not proposed practical, cost-effective alternatives suited for resource-constrained SMEs. Furthermore, studies on future AI innovations in OHS discuss high-end tools like virtual reality, AI-driven hazard identification, and automation without addressing their accessibility for small businesses, leaving a notable research gap in affordable OHS digitalisation.
- **Lack of research on aligning AI systems with South African OHS legislation:** There is little research on how AI systems can complement or integrate with South Africa's OHS Act and related regulations. OHS policy sources note that South Africa's regulatory frameworks have not yet evolved sufficiently to incorporate AI-driven compliance mechanisms. Research on AI in OHS further highlights regulatory gaps and the need for updated policies to address emerging technologies but does not explain how AI-generated data or automated safety reporting could meet compliance requirements. This gap complicates implementation because businesses lack clarity on whether AI technologies can be formally used during audits, inspections, or legal compliance processes.
- **Limited research on AI literacy and digital skill readiness for OHS adoption:** SMEs frequently lack the digital skills and AI literacy required to adopt advanced technologies, yet research seldom assesses these capabilities in the context of OHS compliance. Studies find that South African SMEs struggle with inadequate technical skills, limited infrastructure, and financial constraints factors that directly affect the feasibility of adopting AI-enabled safety systems. Broader global research also confirms that skill shortages impede AI adoption in SMEs, although these studies do not extend their analysis to OHS-specific requirements such as hazard recognition, compliance training, or digital reporting. This leaves the human capacity dimension underexplored.
- **Lack of sector-specific analyses linking AI to SME OHS risks:** SMEs operate across diverse industries—construction, retail, hospitality, logistics each with unique OHS hazards, yet existing literature does not map AI tools to these sector-specific risks. OHS AI literature broadly discusses technologies such as predictive analytics and ergonomic assessment systems without contextualizing them to the risk patterns, common

incident types, or compliance challenges of different SME sectors. Moreover, research in industries like construction demonstrates AI's safety potential but focuses on sector-specific or large-scale use cases, offering limited guidance for SMEs across varied sectors. This results in a knowledge gap on tailoring AI interventions to SME-specific operational realities.

4. Practical Recommendations to address the gaps in literature

- **Limited empirical evidence on AI adoption for OHS in South African SMEs:** Conduct sector-specific empirical studies through collaborations between universities, industry associations, and SME forums. Researchers should use mixed-methods approaches (surveys, interviews, pilot studies) to generate rich, localized evidence of how AI tools can support OHS compliance. Government agencies such as the Department of Employment and Labour can fund targeted research programs aimed at documenting real-world OHS challenges and testing AI prototypes within SMEs.
- **Insufficient research on cost-effective AI-based OHS solutions for SMEs:** Develop low-cost, modular AI tools tailored for SMEs. This can include simplified mobile-based hazard reporting apps, affordable computer-vision tools using basic cameras, and lightweight predictive analytics systems. Partnerships with local tech startups can help produce scalable, low-budget solutions. Policymakers should incentivize development through innovation grants and tax benefits for companies producing safety-focused AI tools.
- **Lack of research on aligning AI systems with South African OHS legislation:** Form regulatory working groups involving policymakers, legal experts, AI developers, and OHS practitioners to update OHS legislation and develop guidelines for AI integration. This group should produce compliance frameworks clarifying how AI-generated data can be used during safety audits, inspections, and incident investigations. Clear regulatory guidance will accelerate adoption and reduce uncertainty.
- **Limited research on AI literacy and digital skill readiness for OHS adoption:** Introduce targeted capacity-building programs to enhance AI and digital literacy among SME owners, safety officers, and workers. This includes short courses, online modules, and free training workshops delivered through SETAs, universities, and private training providers. Training should focus on practical OHS-specific AI knowledge, not general technology skills.
- **Lack of sector-specific analyses linking AI to SME OHS risks:** Conduct sector based OHS risk assessments to map where AI tools can provide the greatest benefit. For example, computer vision may be crucial for construction SMEs, whereas retail SMEs may benefit more from ergonomic AI tools. Develop sector-specific AI-OHS deployment guidelines that match typical risks faced in each industry. Industry associations can champion this work and publish practical guidance.
- **Lack of research on aligning AI systems with South African OHS legislation:** Form regulatory working groups involving policymakers, legal experts, AI developers, and OHS practitioners to update OHS legislation and develop guidelines for AI integration. This group should produce compliance frameworks clarifying how AI-generated data can be used during safety audits, inspections, and incident investigations. Clear regulatory guidance will accelerate adoption and reduce uncertainty.

5. Conclusion

The incorporation of Artificial Intelligence into Occupational Health and Safety frameworks offers substantial potential to enhance compliance among South African small and medium-sized enterprises; however, this promise is substantially untapped due to profound contextual and structural deficiencies. The delineated research gaps including limited empirical data, the lack of economical AI-OHS interventions, discord with prevailing OHS statutes, ethical and data privacy apprehensions, deficient AI proficiency, absent oversight mechanisms, inadequate sector-specific inquiries, feeble integration architectures, suboptimal change-management protocols, and a disjointed national enabling environment illuminates the complex impediments obstructing AI-facilitated OHS progress. Remedying these deficiencies necessitates an orchestrated, multifaceted strategy incorporating the creation of economical AI instruments, revised regulatory and ethical paradigms, bespoke competency-enhancement programs, industry-customized OHS-AI directives, and fortified national innovation infrastructures. In aggregate, the proffered recommendations underscore that substantive advancement hinges not solely on technological ingenuity but equally on institutional preparedness, SME capacity augmentation, and enabling policy architectures. Through bridging these voids via targeted scholarship, synergistic industry-government alliances, and pragmatic deployment tactics, South African SMEs stand to harness AI's full efficacy in bolstering OHS adherence, mitigating occupational hazards, and fostering secure workplaces conducive to enduring viability and market prowess.

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