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Critical Success Factors for Integrating AI Tools into University Curricula for Workforce Readiness

Buhle Yolande Matiwane
Department of Information Systems
Faculty of Management and Commerce
University of Fort Hare
East London, South Africa

Olutoyin Olaitan*
Department of Applied Informatics and Mathematical Sciences
Faculty of Engineering, Built Environment and Information Technology
Walter Sisulu University
East London, South Africa

Abstract. The integration of Artificial Intelligence (AI) tools into university curricula is crucial for addressing the skills gap in the workforce driven by the Fourth Industrial Revolution (4IR). However, challenges such as curriculum misalignment, faculty expertise, and ethical concerns hinder widespread adoption. This study aimed to explore the key factors influencing the integration of AI tools into higher education, using the Technology-Organisation-Environment (TOE) framework. A qualitative literature review was conducted to analyze current research and identify both barriers and enablers of AI adoption in academic programs. Findings revealed that AI has the potential to enhance student performance and employability but is constrained by resource limitations, faculty training needs, and ethical considerations surrounding data privacy and AI usage. Six critical success factors were identified: curriculum alignment with industry needs, faculty training, ethics education, access to AI tools, infrastructure, and resource allocation. The study also highlighted the importance of university-industry partnerships to ensure curriculum relevance and practical experience. The research provides actionable recommendations for educators and policymakers, emphasizing continuous curriculum development, strategic resource investment, and ethical frameworks. Future research should examine the long-term impact of AI integration

*Corresponding author: Olutoyin Olaitan; *oolaitan@wsu.ac.za*

on workforce readiness and academic outcomes, advancing the understanding of educational innovation in an AI-driven world.

Keywords: Artificial Intelligence (AI); University curricula; Fourth Industrial Revolution (4IR); Workforce readiness; Technology-Organisation-Environment (TOE) theory

1. Introduction

Artificial intelligence (AI) is transforming various aspects of life by automating processes and reimagining how data is incorporated and assessed. As a cornerstone of the Fourth Industrial Revolution (4IR), AI aims to create systems that mimic human intelligence through learning from experience and making informed decisions. The rapid advancement of technology necessitates systematic knowledge transfer from educational institutions to students (Zawacki-Richter et al., 2019; Jan et al., 2023). Universities are tasked with preparing students to meet the challenges of this digital era. AI plays a pivotal role in this transition, offering tools that automate processes, enhance decision-making, and improve productivity in the workforce. As highlighted by Abd-Alrhman and Ekenberg (2020), the effective use of data and AI technologies has become a necessity across various industries, including education.

The integration of AI tools in university settings can be structured using the Technology-Organisation-Environment (TOE) theory. The TOE theory, developed by Tornatzky and Fleischer (1990), provides a robust theoretical foundation for analysing how organisations adopt and implement technological innovations. It considers three interrelated contexts: the technological, the organisational, and the environmental. The TOE theory enables universities to assess the factors influencing the incorporation of AI technologies into their educational practices and reimagine what steps to take in addressing such issues.

Furthermore, this study emphasises the importance of establishing strong partnerships between universities and industry stakeholders to ensure that the academic curricula remain aligned with emerging technologies. As educational institutions seek to prepare students for an AI-driven workforce, understanding the practical applications of AI tools in various industries becomes paramount (Kamaruddin et al., 2023). However, the effective integration of AI into educational curricula faces several challenges, including limited faculty expertise, lack of resources, and ethical concerns surrounding data privacy (Wang et al., 2021).

This research investigates strategies that could contribute to universities successfully integrating AI-driven tools and technologies in their curricula to enhance student workforce readiness. This study explored the strategies, challenges, and critical success factors for integrating AI tools into university curricula to enhance student workforce readiness, providing practical recommendations for educators and policymakers.

1.1 Research Questions

Main Research Question

How can universities integrate AI-driven tools and technologies into their curriculum to enhance student workforce readiness?

Sub-Questions

- How are AI tools and technologies currently utilised in the contemporary workplace?
- What are the challenges universities face in integrating AI tools and technologies into their curriculum to enhance student workforce readiness?
- What strategies can universities employ to integrate AI-driven tools and technologies into their curricula for enhancing student workforce readiness?

2. Literature Review

AI integration in education has gained significant attention, particularly for its potential to enhance teaching and learning outcomes. Kamaruddin et al. (2023) highlighted how AI technologies personalise educational experiences, leading to better engagement and improved learning. The implementation of intelligent tutoring systems and automated grading tools is an example of how AI can enhance the effectiveness of teaching by reducing manual workload and offering personalised feedback to students.

AI integration into university curricula is crucial for preparing students to navigate the increasingly technology-driven workforce. Studies consistently show that graduates with AI-related competencies have a competitive edge in job markets where technological proficiency is in high demand (Wang et al., 2021). There is emphasis on the need for AI skills to align with industry expectations, and Cardona et al. (2023) states that close collaboration between universities and industry stakeholders is essential to ensure that curricula remain responsive to emerging technologies and trends.

The growing relevance of AI in industry further reinforces the need for such alignment. Intelligent systems are already transforming sectors like finance, healthcare, and manufacturing through automation, predictive analytics, and workflow optimisation (Mehta, et al., 2023; Bai, 2024). To bridge this gap, universities must adopt more flexible, industry-informed curricula. Interactive AI tools not only build technical proficiency but also foster soft skills such as collaboration and adaptability (Ruiz-Rojas et al., 2024).

However, integrating AI into university curricula is not without challenges. A lack of faculty expertise and ethical concerns surrounding AI, particularly regarding data privacy and bias, remain significant barriers (Ally & Wark, 2020). In South Africa, for instance, these issues are compounded by limited infrastructure and resources, which hinder the widespread adoption of AI tools in education (Nkosi et al., 2024). Despite these obstacles, the rapid advancement of AI technologies offers considerable opportunities for improving educational outcomes and workforce readiness. Developing the capabilities required for AI adoption is crucial to ensuring South African institutions can keep pace with global advancements.

In recent years, AI's impact on industries has been profound, particularly in improving decision-making and operational efficiency (Bai, 2024). This evolution illustrates the need for educational institutions to adapt their curricula to prepare students for an increasingly AI-driven job market. Graduates should be equipped to tackle global and digital challenges, promote self-expertise, and engage in continuous learning to enhance their quality, which ultimately impacts institutional and national competitiveness (Hadiyanto, 2020).

AI tools such as chatbots and predictive analytics can streamline organisational processes, enhancing productivity and decision-making (Bohr & Memarzadeh, 2020). By optimising resource allocation and encouraging creativity, organisations that use AI can gain a competitive advantage (Kim, 2022). However, concerns about job displacement due to automation and ethical issues like algorithmic bias and transparency must be addressed (Manyika et al., 2017). Addressing these challenges is critical to maintaining employee trust and ensuring a smooth transition into an AI-augmented workforce.

While AI automates many tasks, it also creates new roles that require technical skills (Faishal et al., 2023). This shift highlights the importance of lifelong learning programs designed to equip workers with skills resilient to automation. Organisations that develop effective AI strategies can encourage both innovation and efficiency (Karamthulla et al., 2024). Addressing the digital divide is significant in ensuring the successful implementation of AI tools. In South Africa, businesses acknowledge AI's benefits, but adoption remains uneven due to infrastructure limitations and a persistent skills gap (Ntorukiri et al., 2022). Promoting STEM education is essential to building a workforce capable of using AI technologies effectively.

In terms of technological infrastructure, South Africa faces significant challenges, including insufficient resources and systems for effectively implementing new technologies in higher education institutions (Nkosi et al., 2024). Integrating AI into university curricula also presents challenges related to equitable access to education and ethical concerns regarding academic integrity (Familoni & Onyebuchi, 2024). These challenges complicate efforts to integrate AI tools into academic programs designed to enhance workforce readiness.

2.1 Employability for South African Graduates

In South Africa, the integration of AI tools into university curricula is particularly significant given the country's ongoing challenges in higher education and employment. Studies suggest that AI can help develop students' critical thinking and problem-solving capabilities, which are essential in the 4IR (Garcia-Salirrosas et al., 2021; Qazi et al., 2024).

Interactive learning platforms powered by AI can facilitate soft skill development, including collaboration and critical thinking (Ruiz-Rojas et al., 2024). Krisantia (2021) emphasised that integrating both technical and interpersonal skills is vital for aligning graduates with the demands of Industry 4.0. However, many South African students are not exposed to industry-relevant tools during their studies, which leads to a misalignment between academic preparation and labour market expectations (Shiohira, 2021).

To enhance the employability of graduates, it is important to develop the skills, competencies, and personal attributes that will make them more suitable to secure sustainable careers. However, many students are not exposed to the new technologies and strategies used by industries during their study period; they often only learn outdated information (Shiohira, 2021). Social innovations in education also play a pivotal role in addressing skill shortages and expanding lifelong learning opportunities (Kapoor et al., 2018). By incorporating AI tools used in innovative workplaces into the curriculum, universities can more effectively prepare graduates to thrive in an evolving labour market.

2.2 Theoretical Perspective

The Technology-Organisation-Environment (TOE) Theory was applied to frame this study. The theory, developed by Tornatzky and Fleischer (1990) is built upon three constructs, which are, technological, organisational, and environmental contexts. In the context of higher education, these constructs provide a framework for understanding how universities can adopt and integrate AI tools, considering the interplay of technology, organisational capabilities, and environmental factors (Madaki et al., 2023).

The technological context specifically focuses on the availability and suitability of AI technologies, such as learning management systems and AI-driven educational tools. The organisational context considers the readiness of universities to adopt these technologies, including faculty training, institutional culture, and infrastructure. The environmental context highlights external factors such as regulatory policies, industry needs, and partnerships with industry stakeholders that shape how AI tools are integrated into curricula.

According to studies by Chen et al. (2023) and Wu et al. (2025), the TOE theory provides a comprehensive understanding of how various factors influence technology adoption and integration within organisations. Applying this framework to universities allows us to examine how AI tools can enhance educational outcomes by supporting personalised learning, automated grading, and data-driven insights. These technological tools not only improve learning outcomes but also equip students with essential digital skills for the 4IR (Nwosu et al., 2023).

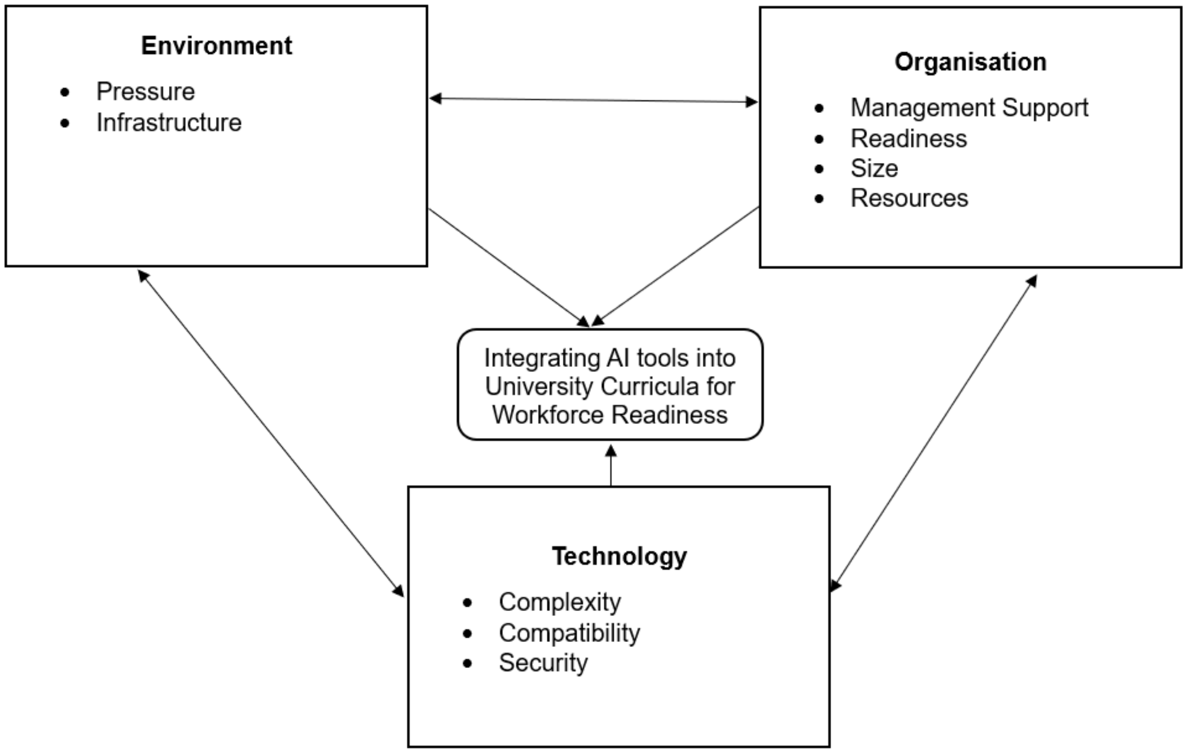

Figure 1: An adaptation of the TOE theory for the Integration of AI tools into university curricula (Tornatzky & Fleischer)

3. Research Methodology

This study followed an interpretive qualitative approach, using secondary data obtained through a systematic literature review. A systematic review was conducted, where various keywords were used and alternated to ensure a comprehensive search for relevant academic material. A systematic review compiles information to answer a particular research problem. This review process includes identifying relevant primary research, critically analysing it, and synthesising its findings (Pollock & Berge, 2018).

Relevant articles that contributed to the theoretical analysis of the Technology-Organisation-Environment (TOE) theory in relation to the integration of AI tools into university curricula for students' workforce readiness were selected for the study. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework was employed in the methodology. According to Page et al. (2021), the PRISMA is a reporting guideline designed to address the poor reporting of systematic reviews.

To identify relevant sources for the research topic, the following resources and databases were used: Google Scholar, UFH library, Research Gate, Science Direct, and IEEE Xplore. These databases were selected for their wide coverage of interdisciplinary research in fields such as information systems, artificial intelligence, and education. ScienceDirect and IEEE Xplore offer peer-reviewed publications on technological innovations, while Google Scholar and ResearchGate provide access to a broad range of academic literature. The search strings included: artificial intelligence in education, current use of AI tools in organisations, challenges of AI integration in organisations, and AI in the workplace. Book chapters and conference proceedings were also included in the literature review.

The TOE theory (1990) focuses on three dimensions comprising technological, organisational, and environmental contexts. Integrating AI tools into university curricula was discussed through the lenses of these contexts. The contribution of this paper is the identification of six critical success factors that facilitate the successful integration of AI tools into university curricula, ensuring that students are equipped with the necessary skills and competencies to meet the demands of an AI-driven workforce.

3.1 Screening of Articles

The initial search was conducted across multiple databases using various keywords related to artificial intelligence in education, resulting in 265 articles. These results needed to be narrowed down to studies that specifically address the integration of AI tools within the educational context and their implications for workforce readiness. The publications had to meet the following criteria to be included: reviewed English-language conference proceedings, journal articles, technical reports, and theses on Integrating AI tools into university curricula, published between 2018 and 2024. Articles that were published before 2018 were consulted in relation to the theoretical framework and critical success factors of AI integration. Table 1 shows the number of articles per database.

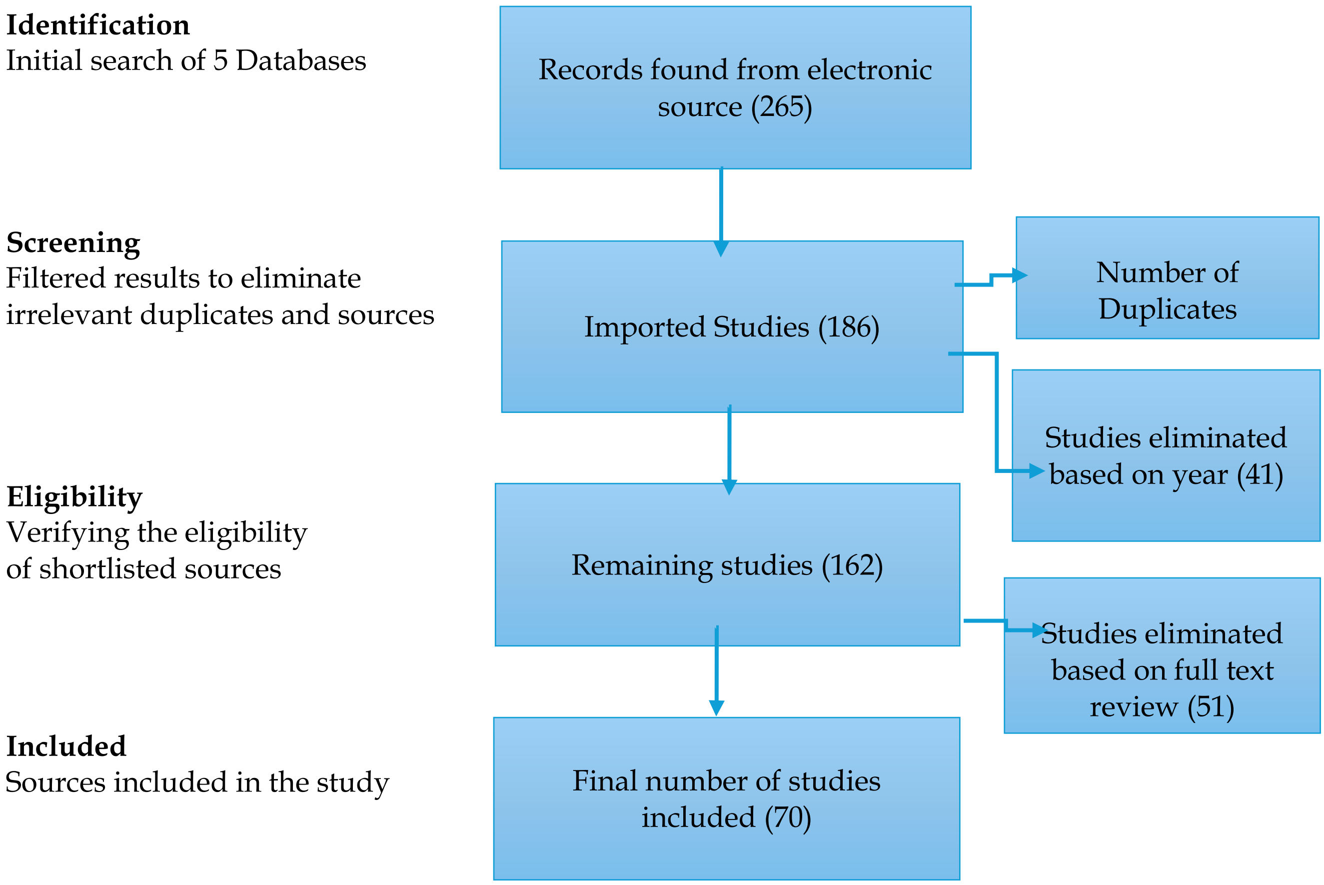

Figure 2: Adopted PRISMA Model (Matiwane & Olaitan, 2024)

Table 1: Number of Articles per Database

Database	**Initial Search**	**1st order search**	**2nd order search**	**Final articles selected**
Google Scholar	120	28	25	21
Institutional Library	35	28	9	8
Research Gate	40	34	30	22
Science Direct	34	26	20	15
IEEE Xplore	36	12	8	4

Table 2: Table exhibiting the inclusion and exclusion criteria of literature

Inclusion Criteria	Exclusion Criteria
(i) Peer-reviewed journal articles and conference papers	(i) Non-peer-reviewed sources (e.g., blogs, opinion pieces, news articles)
(ii) Studies conducted within the Global South context	(ii) Studies unrelated to AI or educational contexts
(iii) Studies investigating the implementation or integration of AI in education	(iii) Studies focusing solely on higher education without reference to AI
(iv) Publications in English	(iv) Publications in languages other than English

(v) Studies presenting real-world applications, pilot projects, or case studies	(v) Studies covering all levels of education without a specific focus on higher education.
(vi) Research focusing on higher education or university settings	(vi) Studies published before 2019 (unless identified as seminal works)
Studies published between 2019 and 2024 (with the exception of foundational works)	

4. Challenges associated with integrating AI tools into university curricula

While highly efficient and beneficial to various stakeholders, the rise of AI technologies in workplaces presents significant challenges for organisations. The rapid advancement and integration of AI tools in sectors such as finance, human resources, and manufacturing create new opportunities to streamline workflows, automate repetitive tasks, and enhance decision-making processes *(Margaryan, 2023)*. Despite these advantages, organisations in the Global South face substantial obstacles that hinder the swift adoption and implementation of these technologies. In addition to infrastructural and resource limitations, AI's potential to revolutionise operational efficiency raises concerns about job displacement, as well as ethical issues related to algorithmic bias, fairness, and transparency *(Manyika et al., 2017)*.

Findings from the literature revealed that universities in South Africa are facing similar challenges in integrating AI into their curricula. One of the primary challenges is ensuring equitable access to AI education for all students. Familoni and Onyebuchi (2024) argue that socioeconomic disparities could deepen if AI learning tools are not made accessible to students from all backgrounds, potentially leading to a widening digital divide. Moreover, ethical considerations surrounding AI are equally relevant in higher education. As Kim et al. (2023) and Akgun and Greenhow (2022) highlight, universities must navigate the complexities of academic integrity, fairness, and responsible AI use to avoid undermining the trust in educational systems.

Addressing these challenges is important for maintaining student and faculty trust and ensuring that AI integration aligns with the university's educational objectives. Furthermore, the adoption of AI in university curricula has direct implications for the employability of graduates. In an AI-driven job market, graduates must develop both technical expertise and soft skills to remain competitive (George, 2023). According to Aboderin & Havenga (2024), higher education institutions play a pivotal role in preparing students for this future workforce by equipping them with relevant skills, competencies, and personal attributes that align with the demands of AI-driven industries.

To fully use AI technologies, organisations need several key elements in place, including leadership commitment, a well-prepared and adaptable workforce, and a solid technological infrastructure. Without these foundational elements, the benefits of AI cannot be fully realised. The specific challenges identified in the literature that inhibit the widespread adoption of AI in institutions are highlighted in Table 3 below. Addressing these issues is essential to unlocking AI's full potential in enhancing productivity, encouraging innovation, and boosting competitiveness in the modern workplace. The challenges are discussed in tandem with the corresponding constructs of the TOE theory.

Table 3: Challenges associated with integrating AI tools into university curricula according to the theory constructs

Theory Construct	Challenges
1. **Technology**	• Complexity of AI tools • Compatibility with existing systems • Security and data privacy concerns
2. **Organisation**	• Limited faculty expertise • Resource constraints • Resistance to change
3. **Environment**	• Industry demands and expectations • Ethical Constraints • Competitive Pressure • Infrastructure

4.1 Complexity of AI Tools

The sophistication of AI technologies can be a barrier to effective integration. Faculty and students may struggle with the complexity of these systems, which can hinder their ability to utilise them effectively in educational settings (Akgun & Greenhow, 2022).

4.2 Compatibility Issues

Existing educational technologies and systems may not be compatible with new AI tools (Kim, 2022). This lack of compatibility can lead to inefficiencies and frustrations during the integration process.

4.3 Security and Data Privacy Concerns

Integrating AI into educational platforms involves handling large amounts of sensitive data, raising concerns about data security and privacy. Breaches can lead to a loss of trust among students and staff, which can delay or prevent full AI integration. Adhering to regulations like South Africa's Protection of Personal Information Act (POPIA) further complicates implementation, requiring additional resources to ensure compliance.

4.4 Leadership Support

Successful integration of AI requires strong support from university leadership. A lack of commitment at the top can result in insufficient resources or a lack of strategic direction for implementing AI initiatives (Hoosen, 2023). Without clear vision and backing from leadership, efforts to integrate AI into curricula may falter.

4.5 Faculty Readiness

Many educators are not adequately trained to teach AI concepts or use AI-driven tools in their instruction. This gap necessitates comprehensive and continuous professional development programs (Paranjape et al., 2019). Furthermore, resistance to change, particularly among faculty accustomed to traditional teaching methods, can significantly slow the adoption process. Studies show that resistance often stems from unfamiliarity with new technologies and concerns over job displacement (Shiohira, 2021).

4.6 Resource Allocation

Institutions often face budget constraints that limit their ability to invest in new technologies and training programs necessary for effective AI integration (Kamalov et al., 2023). Without adequate funding, initiatives may be under-resourced, leading to suboptimal outcomes and hindering the overall effectiveness of AI integration in educational settings.

4.7 Equitable Access

Ensuring that all students have access to AI education is crucial. Disparities in access can exacerbate existing inequalities, particularly for marginalised groups who may already face barriers in education. Institutions should develop outreach programs aimed at underserved communities to promote equitable access to technology education (Al-Qerem, et al., 2023).

4.8 Regulatory and Ethical Considerations

The ethical implications of AI usage, particularly around issues such as algorithmic bias, transparency, and data privacy, present major challenges. Universities must navigate these concerns carefully to maintain trust among stakeholders and comply with both local and international regulations (Ally & Wark, 2020). The lack of established ethical frameworks for AI in education compounds this issue, requiring institutions to develop their own guidelines, which can be resource-intensive (Morley et al., 2020).

4.9 Market Pressures

The rapid pace of technological advancement, particularly in artificial intelligence (AI), places significant pressure on educational institutions in South Africa to continuously adapt their curricula to meet evolving industry needs. As the country grapples with one of the worst-performing education systems globally, the gap between academic learning and workforce demands is widening alarmingly (Mohamed, 2020). Reports indicate that South Africa ranks poorly in international education assessments, with many students lagging behind their peers in other countries, including those with lower GDP per capita (CDE, 2023).

5. Enhancing Graduate Employability through AI Integration

While addressing these challenges is essential for the successful integration of AI into educational settings, it is equally important to investigate how this integration will enhance graduate employability. Integrating AI tools into university curricula not only prepares students for 4IR job market demands but also equips them with essential skills for future challenges.

5.1 Skill Development for Graduates' Employability

In incorporating AI technologies into educational programs, universities provide students with hands-on experience using tools that are increasingly in demand by employers (Zawacki-Richter et al., 2024). Skills such as data analysis, machine learning, and familiarity with automation processes become integral to the curriculum, making graduates more competitive in the job market (Coetzee & Goede, 2024). Akor et al., (2019) indicate that teaching methods that emphasise critical thinking, innovation, and problem-solving are essential for developing these skills in the context of the 4IR. In addition to technical skills, integrating AI into curricula allows for the development of soft skills such as teamwork, communication, and adaptability qualities that employers prioritise alongside technical expertise. The focus on soft skills is increasingly recognised as essential for preparing graduates for the complexities of modern workplaces (Krisantia, 2021).

5.2 Industry Alignment and Practical Experience

Collaborating with industry stakeholders ensures that curricula are aligned with current market needs. This alignment allows students to gain insights into real-world applications of AI technologies and understand industry expectations, thereby enhancing their readiness for employment (Kamaruddin et al., 2023). Garcia-Salirrosas et al., (2021) highlight the importance of occupational experience and corporate sense, making them key factors of influencing employability. Integrating industry partnerships into educational programs opens doors for internships, mentorships, and networking opportunities that can lead to job placements after graduation. Qazi et al., (2023) stated that these connections are invaluable for students entering a competitive job market, as they provide practical experiences that enhance employability.

5.3 Critical Thinking and Lifelong Learning for Students

Engaging with AI tools encourages critical thinking and problem-solving skills among students (Kapoor et al., 2018). These competencies are highly valued by employers who seek adaptable workers capable of navigating complex challenges in an ever-evolving technological landscape. Exposure to rapidly changing technologies encourages a culture of lifelong learning among students. As they learn about AI's capabilities and limitations, students become more inclined to pursue continuous professional development throughout their careers, which is essential in a job market characterised by constant change (Asad & Ajaz, 2024).

6. Critical Success Factors for Integrating AI Tools into University Curricula

The rapid advancement of Artificial Intelligence (AI) technologies presents significant opportunities for improving educational practices and enhancing workforce readiness (Treve, 2024). However, as outlined in Section 6, South African universities face challenges in developing the essential capabilities required for the effective integration of these technologies into curricula. To successfully implement AI tools in educational settings, a clearly defined roadmap is important.

A critical understanding of various concerns is required, including data protection and privacy rights, the cultural context of privacy, the implications of AI in education, and the sensitivity surrounding student information (Huang, 2023). The following strategies were identified through a comprehensive review of extant literature to address these challenges. The six Critical Success Factors (CSFs) outlined below were formulated for the successful implementation of AI tools into the curricula of South African educational institutions.

Table 4: TOE Theory Constructs and Critical Success Factors

TOE Context	Relevant Factors	Related CSFs
Technology	Complexity, Compatibility, Security	Comprehensive Faculty Training, Addressing Ethical Considerations
Organisation	Management Support, Organisational Readiness, Organisational Size	Alignment with Industry Needs, Robust Partnerships with Industry
Environment	Pressure, Infrastructure	Technological Infrastructure, Resource Allocation

6.1 CSF 1: Curriculum Alignment with Industry Needs

To ensure that university curricula are relevant and effective, academic programs must align with the skills and competencies that employers seek in AI-driven industries (Cardona et al., 2023). This alignment not only improves student employability but also prepares graduates to succeed in a competitive job market. Institutions should work with industry stakeholders during the curriculum development process to ensure that various programs meet industry standards.

The Board of Education can select industry partners based on their performance, the technologies they use, and the skills they require (George, 2023). These partners can provide insights into what content educators should focus on, based on the performance of past graduates and future industry needs. Additionally, integrating AI tools into academic programs should reflect current industry practices. Institutions must also continuously update their curricula based on emerging technologies and market trends, using feedback from employers to keep educational outcomes aligned with industry requirements (Carmichael et al., 2018).

6.2. CSF 2: Faculty Training and Support

Providing comprehensive training and professional development opportunities for educators is crucial to equipping them with the necessary skills to teach AI effectively (Salhab, 2024). Faculty must be well-versed in AI concepts and tools. This requires ongoing training programs to keep them updated on technological advancements. Institutions should establish partnerships or memoranda of understanding with industries to facilitate practical sessions for students, complemented by lectures and seminars from industry experts.

Grunhut et al., (2021) emphasised that this collaboration not only enriches students' learning experiences but also supports faculty development through initiatives like Faculty Development Programs and Train-The-Trainer (TTT) workshops. By participating in these workshops, educators can become familiar with advanced technologies and current industry practices, ultimately benefiting their students. Furthermore, institutional support for professional development initiatives is vital, as it provides an environment conducive to collaboration with technology providers, enhancing training opportunities for faculty and ensuring they remain current with the latest advancements in AI (Al-Qerem, et al., 2023).

6.3. CSF 3: Ethics and Responsible AI Training

Addressing concerns regarding data privacy and the ethical implications surrounding AI use is crucial, as it ensures that students are trained to use these technologies responsibly. Developing robust ethical guidelines for AI use in educational contexts is essential to tackle issues such as bias, transparency, and accountability (George & Wooden, 2023). From a technological perspective, ethical frameworks should be integrated within the AI tools utilised in education, ensuring that these technologies adhere to established ethical standards.

In South Africa, the Protection of Personal Information Act (POPIA) of 2013 serves as a guiding framework that restricts individuals from disclosing personal information and regulates data handling practices. Organisationally, institutions must establish policies that promote ethical standards in AI education, encouraging a culture of responsibility among students (Pillai & Sivathanu, 2020). Additionally, the environmental context necessitates compliance with regulatory requirements and societal expectations regarding ethical AI usage, which significantly influences curriculum design. By integrating these ethical considerations into AI education, institutions can effectively address concerns related to data privacy, bias, and accountability.

6.4. CSF 4: Access to Cutting Edge AI Tools

Collaborations between universities and industry stakeholders are crucial for keeping curricula relevant and providing students with real-world experience, particularly in the rapidly evolving field of AI (Mahligawati et al., 2023). Access to advanced AI tools significantly enhances learning experiences, preparing students for practical applications in their future careers. From a technological standpoint, the availability of cutting-edge tools directly impacts learning outcomes by enabling hands-on experiences with current technologies (Naik et al., 2020). However, organisationally, institutions must allocate sufficient resources to acquire and maintain these tools to ensure they remain effective and relevant.

Furthermore, the environmental context plays a vital role; partnerships with tech companies can facilitate access to innovative technologies, enriching educational practices and better preparing students for the workforce (Alotaibi & Alshehri, 2023). Higher education institutions (HEIs) must also overcome infrastructure gaps to ensure equal access to these cutting-edge AI tools, providing a more inclusive educational environment. To achieve this, institutions, policymakers, and technology suppliers can collaborate to provide affordable and accessible AI solutions tailored to the diverse needs of various educational contexts (Tanveer et al., 2020).

6.5. CSF 5: Technological Infrastructure

A robust technological infrastructure is essential for supporting the integration of AI tools into educational settings, encompassing adequate hardware, software, and network capabilities necessary for effective implementation. From a technological perspective, this infrastructure must be capable of handling the complexity and demands of AI applications. Organisationally, institutions need to invest strategically in upgrading their technological capabilities to keep pace with advancements in AI (Kumari, 2023). However, despite the recognised importance of such infrastructure for educational advancement, South African universities often face significant gaps due to underfunding (Qazi et al., 2024).

Given the constraints of limited resources, strategic decision-making in infrastructure development becomes essential. Employing a systematic approach, such as conducting social cost-benefit analyses, is crucial for prioritising investments that can accelerate digital growth and enhance educational outcomes (Sapci, 2020). Additionally, the environmental context significantly influences these investments; external factors such as funding opportunities and technological trends play a vital role in shaping the development of necessary infrastructure.

6.6. CSF 6: Resource Allocation

Adequate resource allocation is essential for integrating AI technologies into educational programs, including funding for technology acquisition, faculty training, and curriculum development. Effective resource allocation directly impacts the quality of technology integration; without sufficient investment, institutions may struggle to implement tools that enhance learning experiences (Garvey, et al., 2022). Demonstrated leadership commitment is essential for effectively allocating resources to AI initiatives, cultivating a culture of innovation, and motivating faculty to integrate new technologies into their teaching practices (Khairullah et al., 2025).

Additionally, external factors like economic conditions and funding availability significantly influence resource allocation decisions. Institutions in economically disadvantaged areas may find it harder to secure necessary funds, which can widen existing inequalities in educational quality (Motala et al., 2023). Bates et al. (2021) highlight the importance of institutions seeking partnerships with industry stakeholders, applying for grants, and advocating for government support. By addressing these resource needs, educational institutions can create a strong framework for successful AI integration, ultimately improving student learning outcomes and preparing graduates for a technology-driven workforce.

7. Conclusion

Integrating Artificial Intelligence (AI) tools into university curricula is not merely an enhancement of educational practices but a critical response to the evolving workforce demands of the Fourth Industrial Revolution (4IR). Guided by the Technology-Organisation-Environment (TOE) theory, this study identified both the challenges and critical success factors associated with AI integration in higher education. The findings demonstrate that successful integration requires addressing technological complexity, securing organisational support, and navigating environmental constraints, including ethical considerations and infrastructure limitations. The research highlights six critical success factors—curriculum alignment with industry needs, faculty training, ethics education, access to advanced tools, robust infrastructure, and strategic resource allocation—which together form a comprehensive framework for effective AI integration. Within the South African context, these insights offer a valuable foundation for institutional decision-making and strategic curriculum development. This study contributes to the growing body of knowledge on educational innovation, particularly in preparing higher education institutions to remain responsive to the challenges and opportunities of a rapidly evolving digital landscape.

8. Recommendation for Future research

This study has underscored the importance of integrating Artificial Intelligence (AI) tools into university curricula to better prepare students for the demands of a workforce shaped by the Fourth Industrial Revolution (4IR). Addressing existing challenges and adopting effective strategies can significantly enhance student readiness for careers in increasingly technology-driven environments.

Beyond the acquisition of technical skills, AI integration fosters critical thinking, problem-solving, and ethical awareness competencies essential for navigating the complexities of modern employment. This research identified six critical success factors that form a foundation for effective integration: curriculum alignment with industry needs, faculty training and support, ethics and responsible AI education, access to advanced AI tools, technological infrastructure, and strategic resource allocation. In addition, collaboration with industry stakeholders is essential for aligning educational programs with evolving market demands. Such partnerships can offer students valuable experiential learning opportunities that strengthen their employability and industry readiness.

Future research should explore the long-term impacts of AI integration on workforce preparedness and academic performance. Comparative studies across disciplines and institutions, especially within developing country contexts, could yield deeper insights into scalable and context-specific strategies. These investigations will contribute to a broader understanding of how AI can drive educational innovation and institutional transformation in a rapidly evolving technological environment.

9. Acknowledgements

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