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Artificial Intelligence (AI) Adoption in Technical and Vocational Education and Training (TVET): A Review

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ABSTRACT

The rapid advancement of Artificial Intelligence (AI) is reshaping educational practices across all sectors, including Technical and Vocational Education and Training (TVET). This review explores the current landscape of AI adoption in TVET, highlighting its applications, benefits, and challenges. Utilizing a structured search strategy, this narrative review synthesizes English-language literature and policy frameworks published between 2016 and 2026 specifically focusing on the TVET ecosystem. AI technologies such as personalized learning systems, intelligent tutoring, generative AI tools, chatbots, and AI-powered virtual and augmented reality are increasingly being integrated into TVET to enhance teaching, learning, and administration. These innovations enable adaptive and data-driven learning experiences, improve assessment accuracy, support instructors in curriculum design, and align training programs with evolving industry needs. Despite these opportunities, the review identifies several challenges that hinder effective implementation, including limited infrastructure, inadequate instructor preparedness, policy constraints, ethical and data privacy issues, and socio-cultural resistance. Addressing these barriers is essential to ensure equitable and sustainable AI integration in vocational education. The review concludes that AI has immense potential to transform TVET into a more personalized, efficient, and future-oriented system, fostering skills that meet the demands of the digital economy. It calls for collaborative efforts among educators, policymakers, and industry stakeholders to promote responsible AI use and build capacity for innovation in the TVET sector.

Keywords: Artificial Intelligence; AI; TVET; Vocational Education, Technical Education

1.0 INTRODUCTION

Artificial Intelligence (AI) refers to a multidisciplinary field of computer science that enables machines to mimic cognitive functions typically associated with human intelligence, including learning, reasoning, problem-solving, and language understanding [1]. It encompasses technologies such as machine learning, natural language processing, computer vision, and robotics. These technologies are designed to process large volumes of data, identify patterns, and make decisions or recommendations without explicit human programming for every task. These applications operate within a predefined domain and cannot perform tasks outside their programmed function. In contrast, general AI envisions machines that possess the ability to learn and apply knowledge across diverse domains, an aspiration that remains largely theoretical at present [2]. The rise of AI is underpinned by advances in computing power, access to vast datasets, and developments in machine learning algorithms. Machine learning, a subset of AI, enables systems to learn from data and improve over time without being explicitly programmed. Other enabling technologies, such as natural language processing (NLP), robotics, and computer vision, have also contributed to AI's growing influence across various sectors, including healthcare, finance, transportation, and, increasingly, education. The relevance of AI has grown significantly in the context of digital transformation and Industry 4.0, where automation and data-driven processes are central to organizational competitiveness. AI systems are being integrated into business models to enhance productivity, optimize operations, and support decision-making [1]

While numerous review papers have explored the adoption of artificial intelligence (AI) in Technical and Vocational Education and Training (TVET), this study complements the existing literature by synthesizing the most recent developments. Specifically, it examines current applications, key trends, benefits, opportunities, and implementation challenges. This framework is illustrated in Figure 1 and detailed in the subsequent sections.

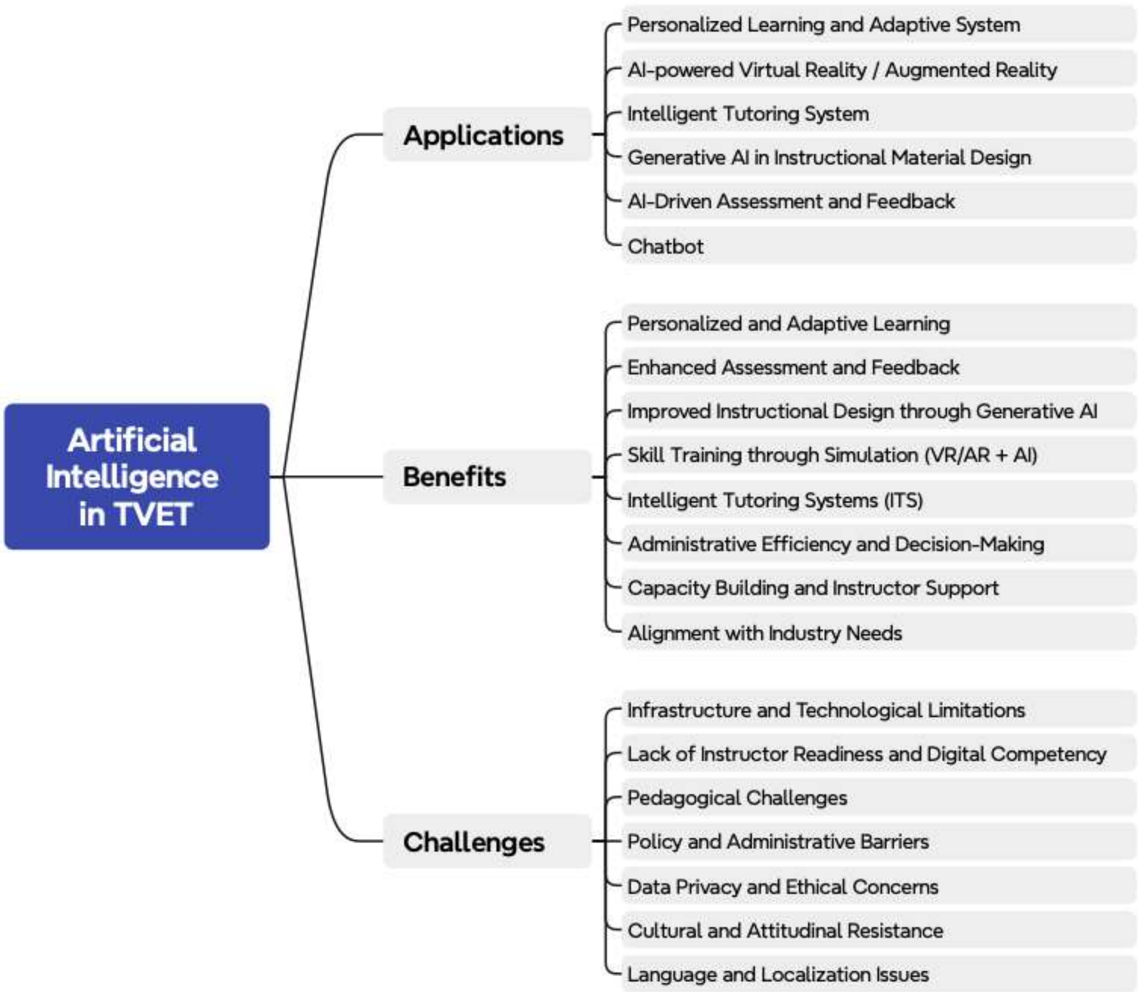

Figure 1: Summary mind map illustrating the applications, benefits, and challenges of Artificial Intelligence (AI) integration in Technical and Vocational Education and Training (TVET).

2.0 LITERATURE SEARCH AND SELECTION

Although this paper is a narrative review, a structured literature search was employed to minimize selection bias. The core search string was structured as follows: ("artificial intelligence" OR AI) AND ("technical and vocational education and training" OR TVET OR "vocational education" OR "technical education") from 2016-2026. Studies were subjectively screened for relevance by the authors; inclusion was restricted to English-language literature that offered distinct empirical data, conceptual frameworks, or case studies on how AI is reshaping vocational curricula, teacher readiness, or institutional infrastructure. Papers focusing exclusively on mainstream higher education (universities) or primary/secondary schooling and any other un-related articles were excluded to keep the focus explicitly on TVET ecosystems. The review also incorporates relevant reports and policy frameworks identified through online searches.

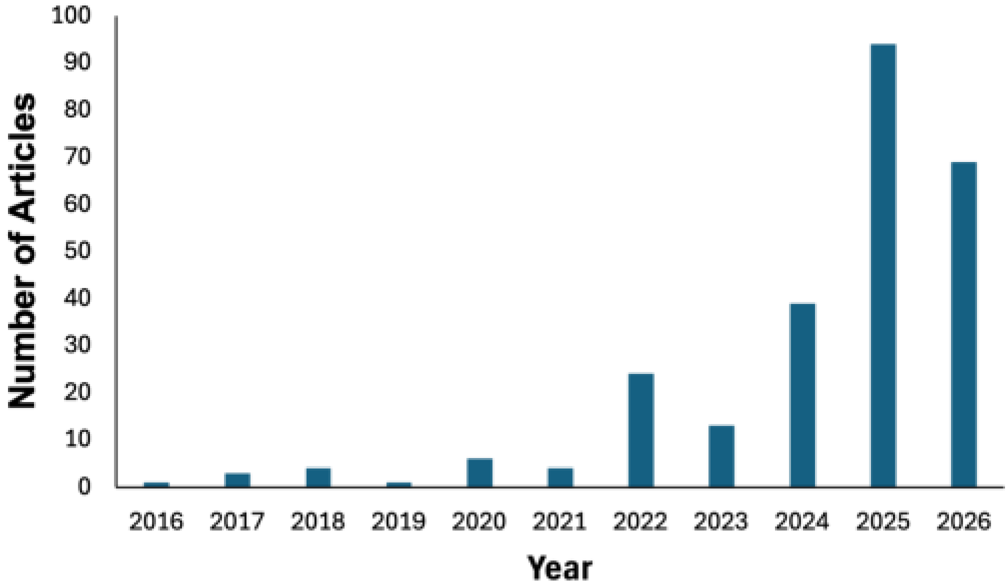

Figure 2: Number of articles with the selected keywords since 2016 in SCOPUS database.

3.0 APPLICATION OF ARTIFICIAL INTELLIGENCE IN TVET

Integrating Artificial Intelligence (AI) into Technical and Vocational Education and Training (TVET) facilitates a pivotal shift toward highly responsive, learner-centric pedagogical frameworks. This section examines how modern AI applications optimize TVET delivery, effectively aligning vocational instruction with rapidly evolving industrial demands and dynamic workforce needs. By leveraging data-driven systems and adaptive learning platforms, institutions can better bridge the gap between classroom training and real-world execution. Fig. 3 provides a overview of the different applications of AI currently reshaping the TVET landscape.

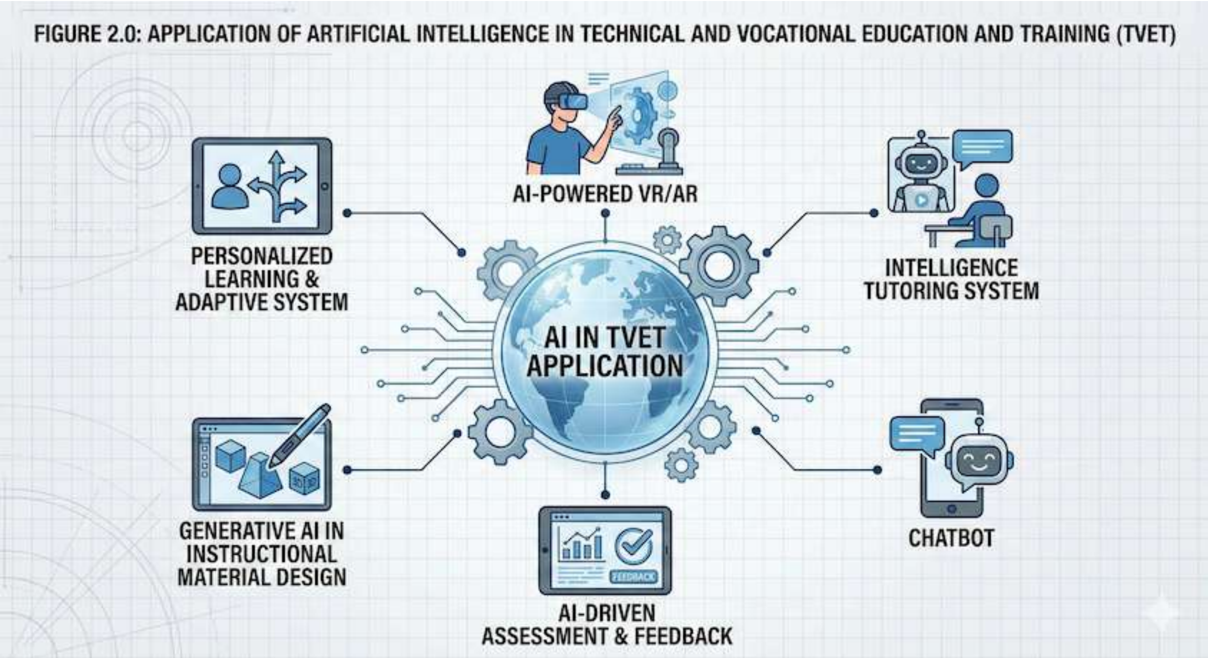

Figure 3: Integration of AI tools into TVET

3.1 Personalized Learning and Adaptive System

The integration of Artificial Intelligence (AI) and digital tools into Technical and Vocational Education and Training (TVET) has enabled new pedagogical possibilities, particularly in the areas of personalized learning and adaptive instructional systems. Personalized learning tailors content and pace to suit individual learners' needs, preferences, and learning styles, while adaptive systems dynamically adjust instruction based on real-time feedback and learner behaviour [3], [4].

Current scholarship in adaptive TVET systems diverges into two primary methodologies: trait-based personalization and standard-driven alignment. Representing the trait-based approach, Hassan et al. leverage deep learning to map instructional content directly to internal learner personality profiles—an architecture highly valuable for addressing the vast demographic and cognitive diversity inherent to vocational cohorts [3]. Conversely, Sajja et al. anchor their adaptive framework around external professional benchmarks, using machine learning to dynamically throttle domain-specific resources and diagnostic assessments for formal professional certification [5].

While both systems successfully demonstrate that AI can move vocational training away from rigid, one-size-fits-all modalities, a significant methodological limitation persists: these frameworks prioritize declarative or cognitive knowledge optimization. There remains a critical gap in showing how these automated adaptive loops can be extended to monitor or calibrate physical, hands-on tool manipulation or real-time workshop safety adaptations.

3.2 AI-powered Virtual Reality/ Augmented Reality

Virtual Reality (VR) and Augmented Reality (AR) are immersive technologies that have revolutionized the way education and training are delivered. VR refers to a fully simulated digital environment that immerses users in a computer-generated space, while AR overlays digital elements onto the real-world environment in real time [6]. When combined with Artificial Intelligence (AI), these technologies evolve into intelligent systems that can personalize learning, adapt in real time, and enhance cognitive engagement.

In the context of Technical and Vocational Education and Training (TVET), AI-powered VR/AR tools are increasingly being used to simulate complex technical tasks and industrial scenarios. These technologies offer learners the opportunity to practice and develop skills in safe, cost-effective, and realistic virtual environments. AI integration enhances this process by analyzing learner interactions, adjusting difficulty levels, and providing tailored feedback in real time [7]

Fajri et. al. introduced the concept of the Smart Teaching Factory, which integrates VR, AI, and animated simulations to support transformative vocational learning [8]. This approach allows learners to engage in factory floor simulations with AI-driven systems that monitor performance, identify weaknesses, and dynamically adjust the training process. The real-time responsiveness of AI ensures that learners are neither under-challenged nor overwhelmed, thus maintaining optimal engagement levels. Kitapcioglu et. al. demonstrated how VR systems enhanced with AI can improve training for high-risk environments, such as medical and emergency services. In their randomized controlled trial, VR-based Advanced Life Support training led to higher immersion and better skill retention [9]. While Fajri et al. highlight AI's role in dynamically adjusting difficulty to maintain engagement in industrial settings, Kitapcioglu et al. demonstrate that in high-stakes environments, AI-personalized trajectories are primarily valuable for long-term skill retention. Together, these studies suggest that AI's primary benefit shifts depending on the risk-level of the vocational environment. The AI component personalized the learning trajectory based on user responses, creating a more effective and individualized learning experience. This model is easily adaptable to TVET disciplines involving safety protocols or mechanical systems.

3.3 Intelligence Tutoring System

Intelligent Tutoring Systems (ITS) are computer-based educational systems designed to provide immediate, personalized feedback and instruction to learners, mimicking the functions of a human tutor. These systems integrate Artificial Intelligence (AI) algorithms to analyze learner inputs, track progress, and adapt content to fit the learner's needs, pace, and knowledge gaps [10]. In the context of Technical and Vocational Education and Training (TVET), ITS can significantly enhance the quality and accessibility of instruction, especially where one-on-one teacher support is not feasible. ITS are particularly useful in simulating guided practice environments for complex technical tasks. By embedding domain-specific knowledge, these systems can monitor a student's actions, identify errors, and provide timely interventions or hints to guide the learning process. This is highly relevant in vocational settings, where mastery of procedures and safety standards is critical. ITS applications in TVET help bridge the instructor-to-student ratio gaps, enabling consistent, on-demand support throughout the learning process [3].

A major intersection in the literature exists regarding the mitigation of student cognitive overload during complex technical tasks through immediate, automated feedback. Researchers largely agree that embedding Intelligent Tutoring Systems (ITS) into vocational curricula serves to bridge high instructor-to-student ratios by functioning as an on-demand virtual mentor. This alignment with competency-based learning is well-documented; Yan et al. [11] and Sajja et al. [5] both establish that ITS architectures successfully map continuous feedback loops directly to individual learner competency profiles. Crucially, the functional boundaries between traditional, heavy ITS architectures and lightweight conversational tools are blurring. Olugbade et al. demonstrate that conversational AI chatbots can replicate these exact scaffolding and reinforcement benefits [12]. By providing real-time, just-in-time instructional prompts directly during hands-on tasks, chatbots achieve similar cognitive-load reduction as structured ITS platforms , suggesting that conversational agents may offer a more agile, economically scalable alternative for resource-constrained TVET environments.

Fajri et.al. extended the application of ITS within their Smart Teaching Factory model, where AI-powered simulations included embedded tutoring features [8]. These systems monitored learner interactions in real-time, offered corrective guidance, and adjusted instructional pathways based on performance analytics. Similarly, the implementation of ITS-like functions was documented within AI teaching factories in Indonesian vocational schools, noting increased engagement and deeper conceptual understanding [13].

Regarding competency alignment, both Sajja et al. and Yan et al. demonstrate that ITS can effectively bridge instructor-to-student ratio gaps by automating routine evaluations and aligning support with individual skill profiles. However, the most profound impact of ITS appears in its ability to manage cognitive load during complex, hands-on tasks. Studies by Olugbade et al. and Fajri et al. agree that embedding real-time ITS feedback into active simulations (such as chatbots or smart factories) prevents learners from being overwhelmed. Despite these positive findings, these studies predominantly rely on short-term observational data, leaving a gap in understanding how continuous reliance on ITS affects a learner's independent problem-solving skills in the long term.

As a conclusion, the benefits of ITS in TVET include improved learner engagement, better learning outcomes, and reduced instructor workload. ITS provide a scalable solution for personalized instruction, allowing students to learn at their own pace while ensuring they meet predefined competency standards. Intelligent Tutoring Systems represent a valuable AI-driven solution for enhancing vocational instruction. Their ability to deliver individualized guidance, automate assessment, and adapt content in real time aligns well with the needs of TVET, particularly in preparing learners for dynamic and skill-intensive industries.

3.4 Generative AI in Instructional Material Design

Generative Artificial Intelligence (GenAI) refers to a class of AI models capable of creating new content such as text, images, audio, code, and videos by learning from large datasets and mimicking underlying patterns. Unlike traditional AI systems that analyze or classify data, GenAI generates novel outputs that can resemble human-created artifacts [14]. Among the most well-known GenAI models are language models like GPT (Generative Pre-trained Transformer), image generators like DALL·E, and multimodal systems such as ChatGPT and Google's Gemini.

There are several types of GenAI, including transformer-based text generators, generative adversarial networks (GANs), and diffusion models. These systems have found wide applications across various industries from entertainment and design to healthcare and education. In the context of education, GenAI is increasingly being used to support the design of instructional materials, assessments, feedback systems, and learning activities.

For Technical and Vocational Education and Training (TVET), the integration of GenAI tools presents a practical solution for instructional challenges such as limited teaching resources, diverse student needs, and rapidly evolving technical curricula. GenAI can assist instructors by automating content creation, including lesson plans, quizzes, hands-on tasks, visual aids, and even assessment rubrics [15]. This allows educators to focus more on engaging with learners and adapting teaching strategies based on real-time performance data.

Deng et.al explored the use of GenAI tools by vocational instructors in China, emphasizing their potential to support English as a Foreign Language (EFL) instruction through automated writing prompts, grammar feedback, and adaptive exercises [15]. The study showed that GenAI can streamline teaching preparation and improve learner autonomy through personalized content delivery. Similarly, Fajri et.al. discussed the integration of generative models in Smart Teaching Factory simulations, where GenAI dynamically generated technical scenarios and instructional visuals to simulate real-world manufacturing processes [8].

Reputable research also highlights the advantages of using GenAI in instructional design. According to Dickey and Bejarano, generative models can democratize content creation, enabling instructors with limited technical backgrounds to produce high-quality, standards-aligned educational materials quickly [16]. Moreover, GenAI enhances instructional flexibility by allowing customization for different learner profiles, vocational disciplines, and industry requirements.

The integration of Generative Artificial Intelligence (GenAI) into education has emerged as a transformative force, reshaping how teaching and learning are conceptualized and delivered. Globally, educational institutions are increasingly exploring the potential of GenAI to enhance instructional design, automate administrative tasks, and personalize learning experiences. These tools, which include large language models, image generators, and multimodal systems, are capable of producing content that mimics human creativity, ranging from essays and quizzes to simulations and feedback mechanisms [17].

One of the most significant contributions of GenAI in education is its ability to support differentiated instruction. By analyzing learner data and generating tailored content, GenAI enables educators to address diverse learning needs more effectively. This personalization not only improves student engagement but also fosters deeper understanding and retention of knowledge [18]. Moreover, GenAI can assist in reducing educators' workload by automating repetitive tasks such as grading, content creation, and feedback generation, thereby allowing instructors to focus on higher-order pedagogical strategies [19].

The use of GenAI in TVET settings is especially beneficial for instructors who face time constraints and require adaptive teaching solutions. These tools can reduce planning time, enhance creativity, and support data-informed decisions in curriculum development.

Generative AI offers a powerful avenue for improving the efficiency, relevance, and scalability of instructional material design in TVET. As these tools become more accessible, TVET instructors must be equipped with the knowledge and skills to harness GenAI responsibly and effectively, ensuring it complements rather than replaces pedagogical expertise.

3.5 AI-Driven Assessment and Feedback

AI-driven assessment and feedback systems are reshaping the way educators evaluate student performance and support learning outcomes. These systems use artificial intelligence to automate the evaluation of learner responses, track progress, detect patterns, and provide instant, personalized feedback [20]. In Technical and Vocational Education and Training (TVET), such technologies are particularly useful in competency-based education models where accurate, continuous, and skill-oriented assessment is crucial.

AI-based assessment tools can analyze open-ended responses, practical task performance, and even simulate examinations in virtual environments. For instance, generative models and natural language processing (NLP) can be used to evaluate written answers or oral presentations, offering constructive feedback aligned with rubrics. According to Hasan et.al [3], such systems not only increase assessment efficiency but also reduce bias by applying consistent evaluation criteria across diverse learners.

Sajja et.al incorporated AI-powered assessments in a floodplain management certification program, where learners received automated performance diagnostics and improvement suggestions after completing training modules [5]. This application improved retention rates and allowed instructors to intervene more effectively. Yan et.al. also emphasized that AI can monitor skills development over time, making assessments more reflective of actual competencies rather than one-time evaluations [11].

Fajri et.al. explored how AI feedback was integrated into simulation-based learning within the Smart Teaching Factory model [8]. Learners received adaptive prompts and corrections while working in virtual manufacturing environments. Similarly, Kitapcioglu et.al. applied AI feedback in emergency training simulations, enhancing performance by identifying errors in real time and guiding learners toward mastery [9].

Wahjusaputri et.al. showed that automated feedback systems in AI-powered teaching factories boosted student confidence and allowed more independent learning [13]. Moreover, Deng et.al. reported the use of AI in language training for vocational instructors, where AI assessed grammar, vocabulary, and structure in writing exercises [15]. These tools provided tailored feedback that matched each learner’s proficiency level, promoting individualized skill development.

Despite these advancements, challenges remain. Successful implementation requires robust infrastructure, ethical data usage policies, and digital literacy among instructors. Nonetheless, the benefits of AI-driven assessment, timeliness, personalization, and data-driven insights make it an invaluable tool in modern TVET. By leveraging platforms like Learning Management Systems (LMS) and integrating intelligent systems, institutions can elevate both learner experience and instructional quality.

3.6 Chatbot

To manage cognitive overload and maintain learner engagement, AI-powered chatbots and assistive platforms have been explored. Olugbade et al. highlighted how chatbots reduce cognitive load by offering instant feedback and scaffolding during technical learning activities [12]. These tools proved especially effective in complex, hands-on vocational environments, where learners benefit from immediate guidance. Chatbots are AI-driven conversational agents that simulate human-like dialogue, enabling real-time interactions between users and systems. They use natural language processing (NLP) to understand, respond to, and guide learners in various instructional contexts [21].

In TVET, chatbots serve as virtual tutors, administrative assistants, or peer learning partners, offering instant feedback, instructional prompts, reminders, and clarification on course content. These tools are particularly useful in self-directed learning environments, where learners may require just-in-time support while engaging in hands-on tasks. Olugbade et al. demonstrated the effectiveness of AI chatbots in managing cognitive load among middle school vocational learners by providing real-time guidance and motivation during problem-solving activities [12].

Chatbots can also help instructors by automating repetitive communication tasks, such as answering frequently asked questions, sending reminders, and collecting feedback. This reduces administrative workload and frees educators to focus on teaching and mentoring. For instance, Fajri et.al included chatbot functionalities in the Smart Teaching Factory framework, enabling students to receive contextual feedback while navigating simulation-based training modules [8].

In a broader context, Liao et al. reviewed educational chatbot deployments and found that they contribute to increased learner satisfaction, autonomy, and academic performance [22]. These systems can adapt to different educational levels and domains, making them especially valuable for vocational training institutions with diverse learners.

3.0 BENEFITS OF ARTIFICIAL INTELLIGENCE IN TVET

The growing presence of Artificial Intelligence (AI) and digital technologies in Technical and Vocational Education and Training (TVET) is reshaping how education is delivered, monitored, and experienced. In alignment with broader digital transformation, the adoption of these technologies promises a more responsive and effective vocational education system. As industries evolve rapidly, TVET institutions must keep pace by leveraging AI and digital tools not only to modernize pedagogical practices but also to prepare students for technology-driven workplaces. This section explores the benefits these innovations bring to various dimensions of TVET beyond the specific applications previously discussed, with a focus on systemic improvements, instructional support, and institutional planning.

3.1 Personalized and Adaptive Learning

AI's capability to personalize instruction according to individual learner needs supports inclusivity in TVET environments. Unlike conventional teaching approaches that often generalize content, AI can analyze learners' progress and dynamically adjust content delivery. This enables instructors to identify struggling learners early and provide timely interventions, reducing dropout rates and boosting self-confidence. Moreover, AI-powered diagnostics offer detailed learner profiles that support individualized career pathway planning, which is crucial in skill-based education settings like TVET [5],[12].

3.2 Enhanced Assessment and Feedback

AI-driven assessment tools can conduct formative and summative evaluations with high precision and speed, offering immediate feedback to learners. These systems are capable of analyzing not just multiple-choice tests but also open-ended responses using natural language processing. For instructors, this reduces time spent on grading and allows more focus on coaching. Additionally, analytic tools integrated into digital platforms help track learning behavior patterns, enabling predictive insights about student outcomes and course effectiveness [3], [15].

3.3 Skill Training through Simulation (VR/AR + AI)

Integrating AI into VR/AR training modules allows learners to experience hands-on scenarios with real-time performance tracking and error correction. In high-risk trades such as electrical installation or machine operation, these tools provide a safe, scalable alternative to physical workshops. AI-enhanced simulations can evaluate psychomotor skills, offer adaptive challenges, and even replicate industry-level quality standards. These innovations contribute to producing job-ready graduates who are familiar with workplace tools and environments before their internships [9].

3.4 Intelligent Tutoring Systems (ITS)

Beyond supporting learners, ITS serve as professional development companions for instructors, offering teaching tips, content suggestions, and real-time diagnostics. Instructors can use ITS analytics to revise lesson plans or provide targeted group activities. These systems also enable differentiated instruction, supporting mixed-ability classes common in vocational training. The ability to scale support without overburdening instructors is particularly useful in resource-limited environments [3], [5].

3.5 Administrative Efficiency and Decision-Making

AI-powered dashboards are increasingly being used to streamline curriculum planning, allocate resources efficiently, and monitor institutional performance. For instance, data from the LMS platform could be leveraged using AI to forecast program enrollment trends, optimize scheduling, and improve compliance with accreditation standards. Such intelligence-driven systems support proactive decision-making, enabling education leaders to respond swiftly to labor market needs and policy shifts [23], [24].

3.6 Capacity Building and Instructor Support

Digital tools provide TVET instructors with access to ongoing professional development opportunities. Through AI-curated content, instructors can pursue micro-credentials, participate in virtual communities of practice, and receive AI-generated teaching recommendations. This creates an ecosystem of continuous learning that is essential for staying updated with technological and pedagogical advancements. In developing contexts, such opportunities help narrow the skill gap between urban and rural educators [25]. Empirical work by Mahuyu highlights that without proactive intervention, automated integrations exacerbate socio-economic disparities. Investigating TVET campuses under resource constraints, the study mapped profound infrastructural inequalities between urban and marginalized centers, while revealing a critical systemic failure to ensure that newly deployed AI learning tools are digitally accessible to learners with disabilities

3.7 Alignment with Industry Needs

AI technologies help bridge the gap between TVET curricula and real-world job requirements by analyzing labor market data, employer feedback, and skill demand trends. This ensures that training remains responsive and relevant. Furthermore, digital tools facilitate collaboration between institutions and industry partners through joint platforms and virtual apprenticeships, ensuring graduates are equipped with in-demand competencies [26].

The literature strongly supports the transformative impact of AI and digital tools in the TVET sector. From improving instructional quality and learner engagement to enhancing institutional efficiency and workforce alignment, these technologies offer multi-dimensional benefits. As the world advances its digital education initiatives, capitalizing on these benefits is essential to ensure the nation's workforce remains competitive and adaptable in a rapidly changing economic landscape.

4.0 CHALLENGES OF ARTIFICIAL INTELLIGENCE ADOPTION IN TVET

While Artificial Intelligence (AI) and digital tools have introduced promising advancements in Technical and Vocational Education and Training (TVET), the journey toward their full adoption is met with a host of challenges. Despite the enthusiasm and policy momentum surrounding digital transformation in education, the integration of these technologies in TVET remains inconsistent and fragmented. Understanding these obstacles is essential to ensure that digital innovations do not widen existing educational disparities, particularly in TVET institutions. This section outlines the key barriers hindering effective AI integration in the TVET landscape

4.1 Infrastructure and Technological Limitations

One of the fundamental barriers to AI adoption in TVET institutions is the uneven access to technological infrastructure. Many rural and semi-urban campuses still face limitations in high-speed internet connectivity, availability of advanced computing hardware, and compatibility with modern software systems. This digital divide poses significant barriers to deploying AI-powered platforms that require constant updates and cloud-based functionality [25]. Additionally, the legacy systems used in some training institutions are not designed to accommodate AI-based analytics, leading to a reliance on outdated administrative platforms that limit innovation [24].

4.2 Lack of Instructor Readiness and Digital Competency

The successful adoption of AI technologies heavily depends on the readiness and digital competence of instructors. Many TVET educators report limited exposure to advanced digital pedagogies and AI-specific applications [23]. This gap is empirically substantiated by a large-scale study from Nwakile et al., which surveyed 416 TVET educators and found that while positive attitudes and pedagogical adaptability were high, actual AI readiness and advanced digital literacy remained strictly moderate [29]. This points to an ecosystem where instructors are willing to adapt but lack the structured, technical training required to move beyond basic foundational usage into advanced AI instructional applications. Professional development programs often focus on basic digital literacy without sufficiently addressing AI-related competencies. This lack of tailored training impedes instructors from fully leveraging AI for personalized learning, intelligent feedback, or predictive analytics [5].

4.3 Pedagogical Challenges

Integrating AI into TVET requires more than technological readiness; it also demands pedagogical alignment. Vocational curricula are often competency-based and emphasize hands-on training, which can be difficult to replicate through AI-driven systems. There are concerns that automated tools may oversimplify complex skill development processes or fail to capture soft skills and psychomotor competencies [28]. Moreover, instructors may struggle to modify their teaching styles to accommodate AI-enhanced systems, especially when they feel such systems devalue human judgment or diminish the teacher's role in mentoring and assessment.

4.4 Policy and Administrative Barriers

The integration of AI into TVET also faces systemic challenges at the policy level. Despite national initiatives promoting digital transformation, there remains a lack of specific frameworks and funding mechanisms that target AI in vocational education. Administrators often operate without standardized evaluation tools to assess the effectiveness of AI-based implementations, making long-term planning difficult [26]. Without a clear roadmap or dedicated budget allocations, many institutions are hesitant to invest in costly technologies that may not deliver measurable outcomes in the short term [29].

4.5 Data Privacy and Ethical Concerns

AI systems require extensive data collection to function effectively. However, concerns around privacy, consent, and ethical use of student data present significant challenges. Issues such as algorithmic bias, transparency in decision-making, and accountability when AI systems fail to act as expected remain unresolved in many educational settings [28]. This is especially relevant in public institutions, where trust and ethical governance are critical to gaining stakeholder acceptance.

4.6 Cultural and Attitudinal Resistance

In some vocational training environments, there is cultural hesitation toward AI adoption. Some educators and stakeholders perceive AI as a threat to traditional teaching roles or even to job security. Others may view AI tools with skepticism, fearing a loss of personal interaction and mentorship that is central to effective TVET instruction [12].

5.0 CONCLUSION

The integration of Artificial Intelligence (AI) into Technical and Vocational Education and Training (TVET) represents a transformative shift toward smarter, more responsive, and industry-aligned learning environments. As reviewed, AI technologies ranging from intelligent tutoring systems and generative AI for instructional design to adaptive learning platforms and immersive VR/AR simulations offer unprecedented opportunities for personalized learning, competency-based assessment, and efficient administration.

However, to advance this field beyond its current stage, future research must address several critical gaps. Specifically, while current literature heavily emphasizes cognitive knowledge acquisition, empirical investigation is urgently needed into how AI and computer vision can accurately assess complex psychomotor skills inherent to vocational trades. Methodologically, the field must transition from short-term, descriptive case studies toward longitudinal, mixed-methods designs that evaluate the long-term impact of AI-driven training on graduate employment rates and workplace adaptability.

Furthermore, translating these insights into practice requires targeted interventions. Practically, TVET institutions should establish industry-co-designed micro-credentials to systematically upskill educators in AI literacy. From a policy perspective, governments must implement equity-focused funding frameworks that subsidize localized cloud infrastructure and open-source AI tools, ensuring that resource-constrained and rural institutions are not left behind. By addressing these methodological, practical, and policy avenues, AI-driven TVET can successfully evolve into a dynamic, data-informed, and inclusive system that empowers learners for the future of work.

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CONFLICT OF INTEREST

Competing interests: No relevant disclosures.

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