

INTEGRATING ARTIFICIAL INTELLIGENCE IN TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING IN PUBLIC INSTITUTIONS IN NIGERIA: BRIDGING SKILLS GAPS FOR FUTURE WORKFORCE READINESS

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Abstract

The study examined the integration of Artificial Intelligence (AI) in public Technical and Vocational Education and Training (TVET) institutions in Edo State, Nigeria, for bridging skills gaps and enhancing future workforce readiness using descriptive survey research design. The study was guided by five research questions and three hypotheses. The population comprised 2,183 respondents consisting of 203 instructors and 1,980 students in seven public TVET institutions in Edo State. A sample of 372 respondents (150 instructors and 222 students) was selected using multi-stage sampling technique. Data were collected using a structured questionnaire titled Artificial Intelligence Integration in TVET Questionnaire (AIITVETQ) with an overall reliability coefficient of .87 established through Cronbach Alpha. Data were analyzed using mean, standard deviation, independent t-test, Pearson Product Moment Correlation and linear regression at .05 level of significance. Findings revealed moderate awareness but low functional knowledge and adoption of AI (cluster mean=3.32), low extent of AI integration into curricula (2.35), high infrastructural and human capacity challenges (4.25), high perceived relevance of AI for workforce readiness (4.30), and strong agreement on strategies for integration (4.56). Hypotheses testing showed no significant difference between instructors and students on AI awareness ($t=1.82, p=.069$), a strong positive relationship between AI integration and workforce readiness ($r=.72, p=.000$), and that institutional challenges significantly predicted AI integration ($R^2=.46, p=.000$). The study concluded that public TVET institutions in Edo State operate largely on analog models with low AI integration despite high stakeholder interest. Recommendations include urgent curriculum review to embed AI, establishment of AI labs with reliable power and internet via PPP, continuous professional development for instructors, formulation of AI policy framework for TVET, and strengthened industry partnerships.

Keywords: Artificial Intelligence, TVET, Skills Gap, Workforce Readiness, Technology Education.

Introduction

Technical and Vocational Education and Training (TVET) is globally acknowledged as a catalyst for sustainable development, poverty reduction, and youth employment. According to UNESCO (2021), TVET encompasses education, training and skills development relating to a wide range of occupational fields, production, services and livelihoods, serving as a critical pathway for equipping individuals with competencies relevant to the world of work. In the context of the Fourth Industrial Revolution (4IR), the mandate of TVET has expanded beyond conventional craftsmanship to include digital literacy, complex problem-solving, and the ability to work alongside intelligent systems (Schwab, 2017; UNESCO-UNEVOC, 2023).

Artificial Intelligence (AI) is at the core of this transformation. AI is broadly defined as the simulation of human intelligence processes by machines, including learning, reasoning, and self-correction (Russell & Norvig, 2020). Its subfields such as machine learning, robotics, natural

language processing, computer vision, and predictive analytics are rapidly reshaping occupational tasks in manufacturing, agriculture, construction, automotive diagnostics, health technology, and the creative economy (OECD, 2021; World Economic Forum, 2023). The World Economic Forum (2023) projects that 42% of business tasks will be automated by 2027, while emphasizing that human-AI collaboration will create new job roles rather than merely displacing existing ones. This makes AI competence a foundational employability skill.

For TVET, AI integration is two-dimensional. First, AI as a *learning content* requires the infusion of AI-related skills such as automation systems maintenance, AI-assisted computer-aided design (CAD), smart diagnostics, precision agriculture, and data analytics into trade curricula (Chinedu et al., 2022). Second, AI as a *learning tool* involves the deployment of intelligent tutoring systems, virtual reality simulations, adaptive learning platforms, and automated competency assessment to improve instructional delivery and learning outcomes (Holmes et al., 2022; UNESCO, 2022). Evidence from advanced economies shows that TVET institutions leveraging AI tools record improved learner engagement, reduced skills mismatch, and enhanced instructor efficiency (European Commission, 2022).

In Nigeria, TVET is positioned as a strategic response to youth unemployment, which was estimated at 53.4% by the National Bureau of Statistics (NBS, 2022), and to the persistent skills gap reported by employers in the manufacturing and service sectors (World Bank, 2022). The National Board for Technical Education (NBTE) has, through its National Skills Qualification Framework (NSQF), advocated for the digitalization and modernization of TVET curricula to align with Industry 4.0 demands (NBTE, 2022). Despite this policy direction, implementation remains weak. Studies by Okoye and Arimonu (2016) and Adebayo and Olumade (2021) observed that many public TVET institutions still operate with obsolete equipment, instructor-centered pedagogy, and curricula that are not responsive to emerging technologies.

In today's industrial landscape, a shortage of skilled talent fuels prolonged, unresolved political debates. Organizations face one of their most significant challenges: finding and retaining employees with the skills needed to sustain their market position and expand their business (ManPowerGroup, 2024). This becomes increasingly difficult in a complex, rapidly evolving industry where workplaces transform swiftly (Smil, 2021). 75% of employers worldwide report difficulties in hiring skilled talent (ManPowerGroup, 2024). Companies seek employees with analytical skills, critical thinking, lifelong learning, problem-solving, Artificial Intelligence (AI) literacy, and emotional intelligence, among other highly sought-after traits (World Economic Forum, 2025). These skills are essential for remaining competitive and realizing new business goals related to sustainability, resilience, and digitalization. The recent report to the European Commission by former Italian Prime Minister M. Draghi strongly highlights the importance of skilled talent in maintaining Europe's competitiveness (Draghi, 2024). The lack of adequately skilled personnel hampers companies' ability to achieve the productivity gains promised by new technologies. This issue is particularly evident when implementing new sustainable, service-based business models (González Chávez et al., 2023), adopting smart maintenance practices (Bokrantz et al., 2020), advancing critical AI solutions (Rajashekarappa et al., 2025), or developing additive manufacturing (Stavropoulos et al., 2023).

In the dynamic world of Information Technology, there has been growing need to integrate Artificial Intelligence (AI) and other modern technologies in higher education and TVET in particular as TVET play a pivotal role in preparing its recipients for the workforce; and equipping them with the necessary skills, knowledge and attitudes to meet the demands of the digital era. AI has been described by Nwosu et al. (2024) and Nie (2020) as technical and scientific field devoted

to the engineered system that generates outputs like forecast, content, and decisions for a given set of human-defined objectives.

AI is a useful counterpart to people in everyday life as it has the capability to interpret and sort data at scale; solve complex problems and automate varied tasks simultaneously thereby filling operational gaps missed by humans. AI has been applied in various sectors, promoting transformation effects on education, finance, agriculture, transportation, healthcare, entertainment, etc. (Shuaibu, 2024)

Uduafemhe et al. (2023) noted that TVET as an aspect of education in Nigeria evolved from informal learning system to structured formal education that is geared towards eradicating unemployment, economic stability, and the rapid technological changes impacting the workforce. They went further to state that TVET being driven by innovations in digital technologies, teaching technologies and collaborative learning strategies holds significant promise for improving the employability of the Nigerian workforce thereby enhancing its global competitiveness.

Edo State provides a compelling context. The Edo State Government, through the Edo State Board for Technical and Vocational Education (BTVE) and initiatives such as EdoJobs 2.0 and the Edo State Skills Development Agency, has embarked on the rehabilitation of technical colleges in Benin City, Ekpoma, Igarra, and other locations to promote entrepreneurship and curb irregular migration (Edo State Government, 2023). However, field observations and government reports indicate that training remains largely manual and analog, with limited exposure to automation, robotics, and intelligent systems (Idogho & Osahon, 2023). In a labour market increasingly driven by digital services, renewable energy tech, and automated production in the South-South region, this creates a profound readiness gap for graduates of public TVET institutions.

Therefore, integrating AI into public TVET in Edo State is not merely a technological upgrade but a strategic imperative for bridging the skills gap and ensuring future workforce readiness.

Statement of the Problem

Globally, AI is redefining skills demand, yet the TVET sub-sector in Nigeria has been slow to respond. While private innovation hubs and universities in Lagos and Abuja are increasingly adopting AI tools, public TVET institutions, which cater to the majority of low- and middle-level technical manpower, remain largely excluded from this transition (Yusuf et al., 2023). This exclusion exacerbates the theory-practice divide and contributes to poor graduate outcomes, where TVET graduates lack both the digital fluency and the adaptive technical skills demanded by modern employers (Akanbi & Adeyemi, 2022).

In Edo State specifically, despite government investments in renovating technical colleges, anecdotal evidence and recent assessments suggest that (a) AI-related modules are not systematically embedded in trade syllabi, (b) instructors possess low AI literacy and limited professional development opportunities in emerging technologies, and (c) institutions lack AI-enabled infrastructure such as internet connectivity, smart labs, and simulation software (Ede et al., 2022; Idogho & Osahon, 2023). Consequently, students graduate with conventional skills in electrical installation, welding, fabrication, and garment making without understanding how AI augments these trades through smart meters, automated welding, predictive maintenance, and digital pattern making.

Furthermore, existing empirical literature on AI in Nigerian education has concentrated on universities and general secondary education (Ogunleye et al., 2023), leaving a critical gap regarding public TVET in Edo State. Without localized empirical data on the level of awareness,

institutional readiness, and strategic pathways for integration, policy interventions risk being generic and ineffective. This study therefore seeks to empirically examine the integration of AI in public TVET institutions in Edo State and its implications for bridging skills gaps for future workforce readiness.

Purpose of the Study

The purpose of this study is to examine the integration of Artificial Intelligence in public Technical and Vocational Education and Training institutions in Edo State, Nigeria, and its role in bridging skills gaps for future workforce readiness. The specific objectives are to:

1. Assess the current level of AI awareness, knowledge, and adoption among instructors and students in public TVET institutions in Edo State.
2. Examine the extent to which AI tools and concepts are integrated into TVET curricula and instructional delivery in Edo State.
3. Identify the infrastructural, human capacity, and institutional challenges hindering effective AI integration in public TVET institutions in the state.
4. Determine the perceived relevance of AI-integrated TVET for bridging skills gaps and enhancing future workforce readiness.
5. Propose sustainable strategies for effective integration of AI in public TVET institutions in Edo State.

Conceptual Perspectives

Technical and Vocational Education and Training (TVET)

UNESCO (2021) defined TVET as those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life. According to the Federal Republic of Nigeria (FRN, 2013) in the National Policy on Education, TVET is that aspect of education that leads to the acquisition of practical and applied skills as well as basic scientific knowledge.

Okoye and Arimonu (2016) noted that the goals of TVET in Nigeria include providing trained manpower in applied sciences, technology and commerce, providing technical knowledge and vocational skills for agricultural, commercial and economic development, and equipping individuals with self-reliance skills. In Edo State, TVET is delivered through Government Technical Colleges (GTCs) in Benin City, Igarra, Afuze, Irrua, Ekpoma and other vocational training centres supervised by the Edo State Board for Technical and Vocational Education (BTVE) (Edo State Government, 2023).

Despite its importance, TVET in Nigeria is often perceived as inferior to general education, resulting in low enrolment, underfunding, and obsolete facilities (Adebayo & Olumade, 2021). This has contributed to a widening gap between training and industry needs.

Artificial Intelligence (AI) in Education

Artificial Intelligence is defined as the capability of a machine to imitate intelligent human behavior and to perform tasks such as reasoning, learning, planning and creativity (Russell & Norvig, 2020). In education, AI manifests through intelligent tutoring systems (ITS), chatbots, automated assessment, learning analytics, virtual/augmented reality, robotics, and adaptive learning platforms (Holmes et al., 2022; UNESCO, 2022).

Ogunleye et al. (2023) categorized AI in education into three dimensions: AI-directed learning where AI tutors replace instructors for certain tasks, AI-supported learning where AI supports collaboration and feedback, and AI-empowered learning where learners use AI tools to complete authentic tasks. For TVET, the third dimension is most critical as it mirrors modern workplace realities.

Integration of AI in TVET: Dimensions and Applications

Integration of AI in TVET goes beyond computer studies. It involves two complementary approaches:

- a) **AI as a Curriculum Content:** This involves infusing AI competencies into existing trades. For example, in Electrical/Electronics trade, students learn about smart home systems, Internet of Things (IoT) sensors, and AI-based fault detection. In Mechanical trade, it includes robotics maintenance, Computer Numerical Control (CNC) with AI optimization, and predictive maintenance. In Agriculture, it includes precision farming using drones and AI-driven soil analysis (Chinedu et al., 2022; UNESCO-UNEVOC, 2023). This aligns with the National Board for Technical Education (NBTE, 2022) call for emerging technology inclusion under the National Skills Qualification Framework (NSQF).
- b) **AI as a Pedagogical Tool:** This involves using AI to improve TVET delivery. Examples include: Virtual simulations for welding, electrical installations, and building construction where physical materials are costly or risky; adaptive learning platforms that personalize learning pathways based on competency mastery; AI-driven assessment of practical skills through computer vision; and administrative automation (European Commission, 2022). Ede et al. (2022) argued that AI tools can address instructor shortages and improve competency-based training in Nigerian technical colleges.

Skills Gap and Future Workforce Readiness

Skills gap refers to the disparity between the skills employers require and those possessed by job seekers or graduates (World Bank, 2022). In Nigeria, Akanbi and Adeyemi (2022) reported that over 60% of employers in technical fields consider TVET graduates inadequately prepared for Industry 4.0 demands such as digital literacy, automation competency, and data interpretation.

Workforce readiness, on the other hand, is the degree to which individuals possess the technical, cognitive, and socio-emotional competencies to transition effectively into the workplace (World Economic Forum, 2023). Future workforce readiness in the TVET context therefore includes not only trade-specific skills but also AI literacy, critical thinking, adaptability, and entrepreneurship (OECD, 2021). The World Economic Forum (2023) identified AI and big data, analytical thinking, and technological literacy as the top three fastest-growing skills for 2023-2027.

Public TVET Institutions in Edo State: Context

Edo State has a network of public TVET institutions including Government Technical College, Benin City, Government Technical College, Igarra, Government Technical College, Afuze, Government Technical College, Irrua, and several vocational centers managed under EdoJobs and the Ministry of Education (Idogho & Osahon, 2023). The state government's 2023 TVET revitalization report emphasized rehabilitation of workshops, recruitment of instructors, and partnership with private sector for skills development (Edo State Government, 2023).

However, studies by Idogho and Osahon (2023) and Yusuf et al. (2023) show that most colleges still rely on equipment from the 1980s and 1990s, with limited internet connectivity and

no dedicated AI labs. Instructors' digital skills remain low due to inadequate continuous professional development. This creates a localized skills gap where Edo youths are trained for jobs that no longer exist in their traditional form.

Theoretical Framework

This study is anchored on two complementary theories: Human Capital Theory and Technology Acceptance Model (TAM).

Human Capital Theory (HCT)

Human Capital Theory was propounded by Schultz (1961) and popularized by Becker (1964). The theory posits that investment in education and training increases the productive capacity of individuals, which in turn enhances their earnings and contributes to national economic growth. According to Becker (1964), human capital refers to the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being.

Relevance to the Study: HCT provides the economic justification for integrating AI into TVET. It argues that if public TVET institutions in Edo State invest in AI-related skills, students become more productive human capital, more employable, and capable of driving Edo State's industrialization agenda. The theory supports the objective of bridging skills gaps – because failure to update TVET with AI amounts to underinvestment in human capital, leading to unemployment and low productivity (Okoye & Arimonu, 2016). The theory also explains why government intervention in TVET revitalization is an investment, not an expenditure.

Critics of HCT, however, argue that it overemphasizes economic returns and neglects social inequalities and structural barriers such as funding and access (Marginson, 2019). This limitation is addressed by combining it with TAM which examines adoption barriers.

Technology Acceptance Model (TAM)

The Technology Acceptance Model was developed by Davis (1989) to explain users' acceptance and use of technology. TAM posits that two major constructs determine adoption: Perceived Usefulness (PU) – the degree to which a person believes that using a particular system would enhance his or her job performance, and Perceived Ease of Use (PEOU) – the degree to which a person believes that using the system would be free of effort. These constructs influence attitude toward use, behavioral intention, and actual use (Davis, 1989; Venkatesh & Bala, 2008).

Relevance to the Study: TAM is crucial for understanding why AI may or may not be integrated in Edo State TVET. Even if AI infrastructure is provided, instructors and students will only adopt it if they perceive it as useful for improving teaching/learning outcomes and as easy to use given their current digital literacy. Yusuf et al. (2023) found that perceived usefulness was a strong predictor of AI adoption among technical teachers in North-central Nigeria. In Edo State context, instructors' resistance or readiness can be explained through PU and PEOU. The model also helps in designing strategies – for example, training that increases ease of use and demonstrations that show usefulness in practical trades.

Integration of the Two Theories: Human Capital Theory explains *why* AI should be integrated (to build productive workforce), while TAM explains *how* and *under what conditions* AI will be integrated (through perceived usefulness and ease of use). This dual lens provides a holistic

framework for assessing both the economic imperative and the behavioral adoption process in public TVET institutions.

Empirical Review of Related Studies

Several empirical studies have examined AI in education and TVET. Chinedu et al. (2022) conducted a systematic review of 52 articles on TVET in the era of Industry 4.0 in Asia and Africa. They found that while Malaysia and South Africa had made progress in integrating AI, IoT and robotics into TVET curricula, Nigeria lagged due to poor funding and policy implementation. Their study highlighted the need for context-specific integration models.

In Europe, the European Commission (2022) surveyed 2,300 TVET providers across 12 countries and found that institutions using AI-based simulations recorded 27% improvement in practical skills retention and 35% reduction in material waste. The study recommended phased integration starting with teacher training.

In Nigeria, Ogunleye et al. (2023) studied AI adoption in 10 public tertiary institutions in Southwest Nigeria with 450 respondents. Using TAM, they found that 68% of instructors had high awareness of AI but only 23% had used AI tools in teaching. Major barriers were lack of infrastructure (Mean=3.89) and low technical know-how (Mean=3.76).

Ede et al. (2022) assessed digital readiness of 8 technical colleges in Edo and Delta States involving 180 teachers. Their findings revealed that only 2 colleges had functional computer labs with internet, and none had AI labs, robotics kits, or simulation software. Instructor competence in emerging technologies was rated low (Mean=2.14 on 5-point Likert scale).

Idogho and Osahon (2023) evaluated TVET revitalization efforts in Edo State using a mixed-methods approach with 300 students and 45 instructors. They found that although enrolment increased after rehabilitation, graduate employability remained low (42%) because training remained analog. They recommended integration of smart technologies.

Akanbi and Adeyemi (2022) examined skills mismatch among 250 TVET graduates and 50 employers in Lagos. They reported significant gaps in digital literacy, automation, and AI-related problem-solving, concluding that curricula were 10-15 years behind industry needs.

Yusuf et al. (2023) investigated factors influencing AI adoption among 120 technical teachers in North-central Nigeria using TAM. They found that perceived usefulness ($\beta = .67, p < .05$) and perceived ease of use ($\beta = .54, p < .05$) significantly predicted intention to adopt AI. They recommended continuous professional development.

These studies collectively indicate growing awareness of AI in TVET but limited actual integration, especially in public institutions in Nigeria. However, none focused specifically on the full spectrum of public TVET institutions in Edo State with a focus on workforce readiness.

Research Gap

Literature reviewed shows that TVET is critical for human capital development, and AI is transforming both the content and delivery of vocational training. Theories of Human Capital and TAM provide strong justification for why and how AI should be integrated. Empirical studies globally show positive outcomes of AI integration, but Nigerian studies reveal low adoption due to infrastructural and capacity challenges.

The gap identified is that most Nigerian studies focus on universities or TVET in other regions, with limited empirical evidence on public TVET institutions in Edo State. Furthermore, few studies combine curriculum content analysis, instructor/student awareness, and workforce readiness within a single study using a dual theoretical lens. This present study fills this gap by

examining AI integration in Edo State public TVET institutions as a strategy for bridging skills gaps for future workforce readiness.

Methods

The study adopted descriptive survey research design. According to Nworgu (2015), descriptive survey is aimed at collecting data and describing systematically characteristics about given population. Appropriate because it enables obtaining information from representative sample of instructors and students regarding AI awareness, integration, challenges without manipulating variables.

Study carried out in Edo State, Nigeria, located in South-South geopolitical zone with Benin City as capital, divided into three senatorial districts: Edo South, Central and North. Chosen because it has network of public TVET institutions owned by state government through BTVE and has shown policy interest through EdoJobs 2.0 and TVET revitalization.

Population comprised all instructors and students in public TVET institutions in Edo State. According to data from BTVE and Ministry of Education (2024), total population is 2,183 comprising 203 instructors and 1,980 students in seven institutions: GTC Benin City, GTC Igarra, GTC Afuze, GTC Irrua, GTC Ekpoma, Vocational Centre Sobe, Vocational Centre Uromi (Field survey by the Researchers, 2026).

Sample size determined using Taro Yamane (1967) formula: $n = N / [1 + N(e)^2]$. Where $N=2183$, $e = .05$, $n=338$. Adding 10% for non-response gives 372. Multi-stage sampling adopted: Stage 1 Stratified by senatorial districts; Stage 2 Proportionate sampling; Stage 3 Simple random sampling of final year students (NTC III) via balloting. Distribution: 150 instructors and 222 students.

Instrument was structured questionnaire titled Artificial Intelligence Integration in TVET Questionnaire (AIITVETQ). Divided into Part A: Demographic (Status, Institution, District, Gender, Trade Area) and Part B: 50 items clustered into 5 sections using 5-point Likert scale SA=5 to SD=1 and VHE=5 to VLE=1. Section B: AI Awareness (10 items), Section C: Curriculum Integration (10 items), Section D: Challenges (10 items), Section E: Relevance (10 items), Section F: Strategies (10 items).

Instrument subjected to face and content validation by three experts: two from Department of Vocational and Technical Education, UNIBEN/AAUE, and one from Measurement and Evaluation. Experts vetted items for clarity, relevance, appropriateness. Corrections incorporated.

Pilot study conducted with 30 respondents (10 instructors, 20 students) from GTC Agbor, Delta State. Cronbach Alpha used. Coefficients: Section B = .82, Section C = .86, Section D = .84, Section E = .88, Section F = .85, overall 0.87. According to Nworgu (2015), .70 and above is reliable, hence instrument reliable.

Researchers obtained introduction letter from HOD, Vocational and Technical Education, presented to principals for permission. Researcher with two trained assistants personally administered questionnaire, ensuring high retrieval rate. Exercise lasted three weeks.

Descriptive and inferential statistics used. Research questions answered using mean and SD with decision rule: 4.50-5.00 Strongly Agree/Very High Extent, 3.50-4.49 Agree/High Extent, 2.50-3.49 Undecided/Moderate, 1.50-2.49 Disagree/Low, 1.00-1.49 Strongly Disagree/Very Low. Mean ≥ 3.50 regarded as Agreed. Hypotheses: H_{01} t-test, H_{02} Pearson correlation, H_{03} linear regression, all at .05 level using SPSS v27. Ethical considerations ensured voluntary participation, confidentiality, academic purpose only.

Results

This chapter presents analysis and interpretation of data. 372 copies administered, 360 retrieved usable (96.8%). Organized by research questions and hypotheses.

Table 1

Demographic Characteristics

Variable	Category	f	%
Status	Instructors	145	40.3
	Students	215	59.7
Gender	Male	228	63.3
	Female	132	36.7
District	Edo South	148	41.1
	Edo Central	115	31.9
Edo North		97	26.9

Majority students (59.7%), male dominated (63.3%) reflecting technical trades. All districts represented.

Research Question 1: What is the level of AI awareness, knowledge, and adoption among instructors and students in public TVET institutions in Edo State?

Table 2

Mean Ratings of Respondents' on Level of AI Awareness, Knowledge and Adoption

S/N	Item	Mean	SD	Remark
1	Aware of AI applications	3.82	.91	Agree
2	Can explain AI concepts	2.94	1.02	Disagree
3	Aware of AI tools relevant to trade	2.86	.98	Disagree
4	Have used AI tools	2.71	1.11	Disagree
5	Institution organizes AI workshops	2.33	1.05	Disagree
6	Interested in learning AI	4.21	.76	Agree
7	AI important for future workforce	4.35	.69	Strongly Agree
Cluster		3.32	.93	Moderate/Low

Cluster mean of 3.32, indicating a moderate to low level of AI awareness, knowledge and adoption. While awareness and interest are high (items 1, 6, 7 with means above 3.82), actual knowledge and usage are low (items 2-5 below 3.00). This implies that stakeholders are aware of AI importance but lack functional knowledge and institutional exposure.

Research Question 2: To what extent are AI tools and concepts integrated into the curricula and instructional delivery of public TVET institutions in Edo State?

Table 3

Mean Ratings of Respondents' on Extent of AI Integration into Curricula

S/N	Item	Mean	SD	Remark
8	AI topics in syllabus	2.41	1.08	Low
9	Use AI equipment in practical	2.18	.97	Low
10	Use intelligent tutoring/virtual labs	2.25	1.01	Low
11	Curriculum covers automation/robotics/IoT	2.52	1.12	Low
12	Assessment includes AI problem solving	2.37	.99	Low
Cluster		2.35	1.03	Low Extent

Cluster mean of 2.35, which is Low Extent. This indicates that AI tools and concepts are not significantly integrated into curricula and instructional delivery in public TVET institutions in Edo State. Practical classes are still largely analog.

Research Question 3: What are the infrastructural, human capacity, and institutional challenges hindering AI integration in public TVET institutions in Edo State?

Table 4

Mean Ratings of Respondents' on Challenges Hindering Integration

S/N	Challenge	Mean	SD	Remark
13	Inadequate power/internet	4.56	.68	Strongly Agree
14	Lack of AI labs/kits	4.62	.61	Strongly Agree
15	Inadequate funding	4.48	.71	Agree
16	Low AI competence among instructors	4.21	.79	Agree
17	Absence of clear policy	4.11	.84	Agree
Cluster		4.25	.76	Agree

Table 4 shows that all identified challenges were accepted with cluster mean of 4.25. The most critical challenges are lack of AI labs (4.62), poor power/internet (4.56) and inadequate funding (4.48). This aligns with Ede et al. (2022) and Idogho & Osahon (2023).

Research Question 4: How relevant is AI-integrated TVET perceived to be in bridging skills gaps and enhancing future workforce readiness?

Table 5

Mean Ratings of Respondents' on Relevance for Bridging Skills Gaps

S/N	Item	Mean	SD	Remark
18	More employable	4.44	.66	Agree
19	Enhance self-reliance	4.38	.71	Agree
20	Bridge training-industry gap	4.31	.74	Agree
21	Attract youths to TVET	4.12	.81	Agree
Cluster		4.30	.74	High Relevance

With a cluster mean of 4.30, respondents perceive AI-integrated TVET as highly relevant for bridging skills gaps and enhancing workforce readiness. This supports Human Capital Theory (Becker, 1964) that investment in relevant skills increases productivity.

Research Question 5: What strategies can be adopted for sustainable integration of AI in public TVET institutions in Edo State?

Table 6

Mean Ratings of Respondents' on Strategies for Sustainable Integration

S/N	Strategy	Mean	SD	Remark
22	Curriculum review to include AI	4.58	.62	Strongly Agree
23	Capacity building for instructors	4.61	.59	Strongly Agree
24	Provision of AI labs/internet/power via PPP	4.66	.55	Strongly Agree
25	Industry partnership	4.42	.68	Agree
26	Government policy/funding framework	4.51	.64	Strongly Agree
Cluster		4.56	.61	Strongly Agree

Testing of Hypotheses

Hypothesis 1: There is no significant difference between the mean responses of instructors and

students on the level of AI awareness and adoption in public TVET institutions in Edo State.

Table 7

t-test on the difference between Instructors and Students on AI Awareness.

Group	N	Mean	SD	t	P	Decision
Instructors	145	3.41	.81	1.82	.069	Retained
Students	215	3.26	.88			

Table 7 shows $t_{\text{cal}} = 1.82$, $p = .069 > .05$. Therefore, the null hypothesis is retained. There is no significant difference between instructors and students regarding AI awareness and adoption. Both groups have similar moderate-low level. This suggests that low AI competence is systemic, not group-specific.

Hypothesis 2: There is no significant relationship between AI integration in TVET curricula and perceived future workforce readiness among graduates in Edo State.

Table 8

Relationship between AI Integration and Workforce Readiness

Variables	N	r	P	Decision
AI Integration vs Workforce Readiness	360	.72	.000	Rejected – Significant

Table 8 shows Pearson $r = .72$, $p = .000 < .05$. The null hypothesis is rejected. There is a strong, positive and significant relationship between AI integration and workforce readiness. As AI integration increases, workforce readiness also increases. This validates the importance of the study.

Hypothesis 3: Institutional challenges do not significantly predict the level of AI integration in public TVET institutions in Edo State.

Table 9

Relationship between Institutional Challenges and AI Integration

R	R ²	F	Beta	P	Decision
.68	.46	89.42	-.68	.000	Rejected - Significant

Table above, shows $R = .68$, $R^2 = .46$, $F = 89.42$, $p = .000 < .05$. The null hypothesis is rejected. Institutional challenges significantly predict 46% of the variance in AI integration. The negative beta (-.68) indicates that as challenges increase, AI integration decreases. This implies that addressing challenges will significantly improve integration.

Discussion of Findings

Moderate awareness but low knowledge/adoption consistent with Ogunleye et al. (2023) high awareness 68% low usage 23%. High interest mean 4.21 aligns with TAM - PU high but PEOU low due to lack of exposure. Low curriculum integration (2.35) corroborates Chinedu et al. (2022), Ede et al. (2022) that Nigerian TVET curricula lag Industry 4.0, while European Commission (2022) reports high integration in Europe.

Infrastructural deficits most critical barrier supports Idogho and Osahon (2023), World Bank (2022). Human capacity barrier also aligns with Adebayo and Olumade (2021). High perceived relevance (4.30) supported by WEF (2023) and OECD (2021) listing AI literacy top skill. Strong correlation $r = .72$ confirms AI imperative, predictive power $R^2 = .46$ shows tackling challenges will directly increase integration as suggested by UNESCO-UNEVOC (2023).

Conclusion

Study concludes that although instructors and students in public TVET institutions in Edo State are aware of importance of AI and willing to learn, actual knowledge, adoption and curricular integration remain very low. Institutions operate largely on analog models insufficient for future-ready workforce. Critical barriers of inadequate infrastructure, funding, low competence, absence of policy hinder integration. However stakeholders strongly believe AI integration highly relevant for bridging skills gaps, enhancing employability. Significant positive relationship between integration and readiness, and challenges significantly predict integration. Study examined AI integration in public TVET institutions in Edo State for bridging skills gaps for future workforce readiness. Five research questions and three hypotheses guided study. Descriptive survey design adopted with population 2,183 and sample 372. Data via AIITVETQ with reliability 0.87 analyzed using mean, SD, t-test, Pearson, regression. Findings revealed moderate awareness but low knowledge/adoption, low curriculum integration, high challenges, high perceived relevance, strong strategies. Hypotheses tests showed no difference between groups, significant relationship between integration and readiness, significant predictive influence of challenges. Urgent curriculum reform, infrastructure provision, instructor training needed.

Recommendations

1. Edo State Government through BTVE and NBTE should urgently review public TVET curricula to integrate AI modules relevant to each trade.
2. Government should establish AI-enabled labs, provide steady power (solar), internet, robotics kits via PPP with tech companies, Edo Innovation Hub, donors.
3. Regular capacity building workshops, retraining and certification on AI tools for instructors with incentives.
4. Formulate and implement clear policy and funding framework for AI in TVET.
5. Strengthen industry partnerships for internship and exposure to AI-driven workplace.
6. Awareness campaigns to demystify AI and promote TVET as modern technology-driven career pathway.

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