



Received: 10-03-2025
Accepted: 20-04-2025

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Future-Proofing Skills in the Global South: Strategic Directions for Transforming Technical and Vocational Education and Training (TVET)

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DOI: <https://doi.org/10.62225/2583049X.2025.5.2.4730>

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Abstract

This article provides a comprehensive examination of strategies to transform vocational education systems across the Global South to meet the evolving demands of 21st-century labor markets, societal challenges, and development imperatives. It explores the need to reposition vocational training as a dynamic, inclusive, and future-oriented system capable of addressing technological disruptions, demographic pressures, environmental vulnerabilities, and systemic inequities. The analysis is structured around key thematic areas, including curriculum modernization, digital transformation, green skills integration, governance reform, industry partnerships, educator professionalization, and innovative financing mechanisms.

Drawing from contemporary scholarship and global policy frameworks, the paper emphasizes the importance of aligning skills development with national development goals and labor market realities. A central argument is that vocational training must move beyond narrow technical

instruction to encompass holistic learning approaches that foster adaptability, critical thinking, and civic agency. The study also underscores the role of data-driven decision-making, quality assurance mechanisms, and performance-based monitoring as pillars of system responsiveness and accountability.

Particular attention is given to equity, inclusion, and gender responsiveness, advocating for policies and practices that eliminate structural barriers to access and participation. Furthermore, the paper addresses financing challenges by proposing diversified and innovative funding models that blend public, private, and philanthropic contributions.

Overall, the article presents a strategic framework for reform that is grounded in sustainability, social justice, and cross-sector collaboration. It concludes by highlighting the transformative potential of well-governed, inclusive, and adaptive vocational education systems in fostering resilience and equitable growth across the Global South.

Keywords: TVET Reform, Digital Transformation, Green Skills, Equity and Inclusion, Skills Financing, Vocational Education Policy

1. Introduction

In the 21st century, global transformations in technology, demography, climate, and economic structures are reshaping the nature of work, education, and development at an unprecedented scale. These shifts are particularly consequential for the Global South, encompassing nations across Africa, Asia, and Latin America, where demographic pressures, technological acceleration, and systemic inequality intersect. While these regions face acute challenges, they also possess immense opportunities to redefine pathways to inclusive growth. Central to this transformation is the urgent need to revitalize Technical and Vocational Education and Training (TVET) systems, making them more responsive, future-oriented, and socially just (ILO, 2021).

Historically, TVET in many developing countries has been characterized by chronic underinvestment, fragmented governance, and peripheral status within national education strategies (Allais, 2012). Despite their potential to advance employability, foster equity, and stimulate industrial development, vocational systems have often remained outdated and disconnected from

contemporary labor market demands (Lim *et al.*, 2020). The intensification of digital transformation, combined with evolving employer expectations, has exposed the limitations of traditional TVET institutions, especially their inability to deliver the adaptive and hybrid skills increasingly required across industries (UNESCO, 2023). This challenge is particularly stark in regions with rapidly growing youth populations and persistent unemployment, where the disconnect between training and employment is both a social and economic liability (Majgaard & Mingat, 2012). The Fourth Industrial Revolution, further accelerated by the global COVID-19 pandemic, has expanded the definition of employability. Today's workers require not only technical proficiencies, such as digital literacy, environmental adaptability, and data analytics, but also transversal competencies like problem-solving, teamwork, and emotional intelligence (ILO, 2021). TVET systems can no longer operate under narrow vocational paradigms; instead, they must evolve into inclusive platforms for lifelong learning, fostering cross-sectoral capabilities and institutional resilience (Lewin, 2023). This paradigm shift necessitates structural changes across curricula, governance models, financing strategies, and workforce development approaches.

However, systemic inequities continue to undermine the promise of vocational education. Gender disparities, regional inequalities, and socio-economic exclusion remain prevalent in many TVET systems. Access to quality training is often limited for women, rural populations, and persons with disabilities (Afeti, 2018). In addition, cultural stigmas surrounding vocational education, combined with quality-control challenges, deter learners from pursuing TVET pathways. Institutional ties with employers remain weak in many cases, resulting in curricula that are misaligned with industry expectations and labor market trends (Oketch, 2016). Against this backdrop, it is imperative to construct a coherent strategy to transform TVET into an engine for inclusive, green, and digitally-driven development.

Digitalization represents a transformative force in this regard. The rise of artificial intelligence, teleworking, and machine learning has altered employment landscapes globally. Yet, for many countries in the Global South, low internet penetration, digital illiteracy, and limited teacher readiness hinder innovation (UNESCO, 2023). Addressing this divide requires investment in both physical infrastructure and human capacity. Digital transformation also demands the adoption of flexible, modular, and competency-based curricula, designed to accommodate diverse learning needs across formal and informal sectors (Allais, 2012). As Afrihyia *et al.* (2025) highlight, the integration of AI and data analytics in education and health sectors has demonstrated the potential for personalized, outcome-driven learning models, approaches that could be replicated within TVET systems to enhance scalability, feedback, and relevance.

Environmental sustainability is equally vital in future-proofing TVET. The climate crisis has far-reaching implications for employment and economic development, particularly in vulnerable regions. As countries work to meet the Sustainable Development Goals (SDGs)—especially SDG 4 (quality education) and SDG 13 (climate action)—there is growing recognition that vocational training must prepare learners for green and circular economies. Lim *et al.* (2020) stress that sustainability should not be an elective or

isolated theme but a core organizing principle of vocational systems. Learners must be equipped with the knowledge and technical skills to contribute meaningfully to sectors such as renewable energy, sustainable agriculture, waste management, and green construction. Moreover, institutions themselves should embody sustainability through green infrastructure, energy efficiency, and environmentally conscious practices (UNESCO, 2023).

Inclusion must remain central to this reform agenda. Despite the expansion of educational opportunities in recent decades, many communities continue to face systemic exclusion from TVET. Urban centers often lack the capacity to absorb rapidly growing youth cohorts, while rural areas suffer from limited infrastructure, entrenched gender norms, and economic barriers (Afeti, 2018). Future-focused TVET systems must dismantle these barriers through targeted policy interventions, inclusive pedagogy, and strategic outreach. Training programs must also reflect the lived realities of diverse learners, offering pathways that are flexible, context-sensitive, and empowering (ILO, 2021).

Reimagining TVET also involves reconsidering how systems are funded and governed. Traditional reliance on public funding has proven inadequate in the face of rising costs, demographic pressures, and technological complexity. Innovative models, including public-private partnerships (PPPs), performance-based funding, and income-sharing agreements, offer potential avenues for sustainable financing (Oketch, 2016). Yet, such mechanisms require strong regulatory frameworks to ensure accountability and equity. Additionally, as Apelehin *et al.* (2025) argue, professional development for educators and institutional leaders is essential. Building inclusive and innovative institutional cultures depends on equipping staff with leadership, pedagogical, and change management competencies.

The alignment of TVET with labor market intelligence is another strategic priority. Accurate, real-time labor market information systems (LMIS) are critical for aligning training supply with demand. These systems must track job trends, skill shortages, and employer feedback to inform curriculum design, admissions priorities, and industry partnerships (ILO, 2021). However, in many regions, LMIS are underutilized or disconnected from training institutions. Bridging this gap is necessary to ensure that vocational systems remain dynamic, evidence-driven, and responsive.

Lessons from international models underscore the value of well-resourced, industry-connected, and socially inclusive TVET systems. Germany's dual system and Singapore's SkillsFuture framework illustrate the effectiveness of co-designed, lifelong learning ecosystems (Lewin, 2023). Yet, rather than replicating these models wholesale, countries in the Global South must adapt their underlying principles, such as stackable credentials, employer collaboration, and flexible delivery, to local economic and cultural contexts (UNESCO, 2023). Innovations such as micro-credentials, mobile learning, and decentralized accreditation mechanisms hold particular promise in extending access to informal workers, school dropouts, and displaced populations (Allais, 2012). However, realizing this potential will require regulatory harmonization, digital trust frameworks, and capacity building across sectors.

Ultimately, TVET transformation must be embedded within wider national reform strategies. Structural challenges such as youth unemployment, informal economies, political instability, and climate risks cannot be addressed in

isolation. TVET must align with broader initiatives in industrial policy, social protection, and environmental planning (ILO, 2021). As Gobile *et al.* (2025) note, cross-sectoral integration is essential for ensuring that skills development strategies contribute to economic inclusion, social justice, and digital empowerment.

This paper moves from diagnosis to strategy, offering a comprehensive roadmap for reimagining TVET in the Global South. Drawing from global best practices and grounded in regional realities, it explores critical reform areas: curriculum modernization, digital transformation, green skills integration, labor market linkages, inclusive financing, educator capacity, and equity. Each section emphasizes practical, evidence-based solutions to advance systems that are not only fit for the future but capable of shaping it.

2. Reframing TVET: A Strategic Conceptual Framework

In response to the rapidly shifting demands of 21st-century labor markets, Technical and Vocational Education and Training (TVET) systems in the Global South must undergo a fundamental reimagining. Historically framed as utilitarian mechanisms for supplying mid-level labor to industrial sectors, TVET systems have too often operated with a narrow, reactive focus. In an era defined by the Fourth Industrial Revolution, digital globalization, and intensifying socio-economic disparities, this legacy model is increasingly inadequate. A strategic conceptual framework is therefore required, one that positions TVET as inclusive, digitally enabled, future-facing, and fully aligned with broader development goals.

This reframing begins with redefining the purpose of vocational education. Rather than viewing TVET solely as a tool for labor market insertion, it must be recognized as a foundational public asset, capable of advancing human development, economic resilience, and social inclusion. Ali, Rahman, and Karsidi (2024) argue that many institutions in the Global South are structurally constrained, limiting their ability to respond to the complexities of informal economies and digital exclusion. In today's context, employability hinges on a blend of cognitive flexibility, technological proficiency, and continuous learning. As Seleke and Teis (2025) assert, TVET must evolve into a digitally integrated system, designed to anticipate, not just react to, transformations in global labor dynamics.

Digital transformation, however, is not merely a technological upgrade; it demands systemic realignment. Infrastructure limitations, inadequate access to devices, and insufficient digital competencies among educators continue to hinder progress. Akomolafe *et al.* (2025a), drawing from health data analytics in chronic disease management, propose feedback-driven ecosystems that can be adapted to TVET to enhance curriculum agility and program responsiveness. These models suggest that embedding real-time labor market feedback into curricular design could ensure greater alignment between training and employment outcomes.

In this context, industry collaboration is indispensable. As Niwamanya *et al.* (2025) emphasize, co-designed training programs that involve private sector stakeholders in curriculum development and delivery significantly enhance workplace relevance. In the health sector, for example, Akomolafe *et al.* (2025b) show how predictive analytics

have supported early diagnosis and resource planning. The same principles, anticipatory design, iterative refinement, and user-centered learning, must inform TVET's engagement with industry.

A central tenet of this strategic framework is labor market alignment. Many TVET systems operate independently of national economic planning or industrial policy, weakening their impact. Ali, Rahman, and Karsidi (2024) argue that embedding TVET into national development strategies is essential to ensure coherence and effectiveness. Parua and Yang (2024) further stress the need for real-time analytics and labor market intelligence systems that inform curriculum updates, track skills shortages, and support evidence-based policymaking.

However, labor market alignment alone is not sufficient. Addressing the historical and structural exclusions that have limited access to TVET is critical. Women, people with disabilities, and rural populations continue to face barriers to participation. Leong (2024) calls for system-wide reforms that incorporate flexible learning modalities, mobile-based instruction, and micro-credentialing to expand access. These tools are especially important for reaching underserved learners outside of traditional classroom environments.

Institutional inclusivity must also be supported by culture and practice. This includes offering financial aid, localized language instruction, and active community engagement. Yusvana (2024) emphasizes that TVET must instill civic values such as environmental responsibility, equity, and global citizenship alongside technical competence. Similarly, Augustine *et al.* (2025) propose trauma-informed pedagogies and psychosocial support systems that accommodate learners exposed to adversity, fostering more holistic and empathetic learning environments.

Quality assurance remains a foundational pillar of the strategic framework. Without clear accreditation mechanisms, national qualification frameworks, and outcome monitoring systems, vocational credentials risk losing their value. Asad *et al.* (2023) identify the absence of graduate tracking and employer satisfaction surveys as major weaknesses in many current systems. Strengthening QA mechanisms requires not only international benchmarking but also local contextualization to ensure relevance and legitimacy.

Resilience and adaptability must be embedded across TVET design. In an age marked by pandemics, climate volatility, and economic shocks, vocational training must integrate sustainability competencies, systems thinking, and risk literacy. Sudan (2021) highlights the need to mainstream environmental education within technical curricula, preparing learners to engage in regenerative sectors such as renewable energy, sustainable construction, and climate-smart agriculture.

The proposed strategic framework must operate at three interrelated levels:

- **Macro level:** Reforming governance, funding structures, and national coordination mechanisms.
- **Meso level:** Enhancing institutional leadership, improving curriculum responsiveness, and developing educator competencies.
- **Micro level:** Redesigning instructional approaches, diversifying assessment tools, and expanding student support services.

Each of these layers must interact as part of an integrated ecosystem, characterized by inclusion, adaptability, quality,

and sustainability. As Seleke and Teis (2025) contend, this framework must remain flexible and iterative, shaped by continuous evidence generation and intersectoral collaboration.

Ultimately, reframing TVET in the Global South is a developmental imperative. No longer a marginal or remedial stream, vocational education must be repositioned at the heart of national development strategies. Drawing from interdisciplinary insights in education, health, data science, and labor economics, this conceptual approach enables TVET to evolve into a transformative force for social equity, economic participation, and technological empowerment.

2.1 Global Trends and the Future of Work

The world of work is undergoing fundamental shifts, driven by converging global forces, digital innovation, demographic transitions, environmental urgency, and changing economic paradigms. These transformations are redefining the skillsets required for labor market participation, particularly in the Global South, where educational and employment systems are already contending with entrenched structural inequalities. In this context, Technical and Vocational Education and Training (TVET) systems must evolve to not only correct historical imbalances in quality and relevance but also anticipate and respond to the emerging complexities of future labor markets.

One of the most profound developments has been the expansion of remote and hybrid work models, accelerated by the COVID-19 pandemic and sustained by improvements in digital infrastructure. As Okoli *et al.* (2024) note, this shift is influencing urbanization patterns and labor mobility in high-income countries, while presenting both opportunities and challenges for developing regions. In the Global South, remote work offers a chance to connect rural populations to global labor markets but simultaneously exposes deficits in digital infrastructure, regulatory capacity, and institutional adaptability.

Parallel to these changes, human resource management practices are also evolving. Appoh *et al.* (2024) highlight the increasing emphasis on workforce agility, continuous upskilling, and soft skill development—attributes such as collaboration, adaptability, and emotional intelligence are becoming central to employability. TVET curricula must adjust accordingly, moving away from rigid, job-specific training to embrace interdisciplinary and competency-based models that reflect the fluidity of contemporary careers.

Technological advancements, particularly in artificial intelligence, data analytics, and blockchain, are transforming both labor systems and educational environments. Apelehin *et al.* (2025) emphasize AI's potential in delivering personalized learning experiences, while Afrihyia *et al.* (2024) demonstrate how data analytics in healthcare improves resource allocation and strategic planning. These tools offer instructive models for TVET, enabling real-time skills forecasting and curriculum alignment with labor market demands. Furthermore, frameworks such as the one proposed by Okoli *et al.* (2024) can help track educational disparities and tailor interventions for underrepresented learner populations.

The changing legal and industrial relations landscape further underscores the need for TVET reform. Uzougbo *et al.* (2023) and Gobile *et al.* (2024) highlight the impact of

automation, platform-based work, and algorithmic management on labor rights and employment norms. To navigate this terrain, TVET systems must equip learners with legal literacy and digital rights awareness, ensuring they are empowered to work within, and help shape, evolving regulatory environments.

Institutional adaptability is also vital. As Apelehin *et al.* (2025) argue, building innovation-friendly and inclusive organizational cultures is essential to staying relevant. For TVET, this means transitioning from bureaucratic, instructor-led approaches to more agile, learner-driven models.

In sum, future-proofing TVET in the Global South demands a systems-level response, one that integrates education into broader strategies for digital development, industrial modernization, and social equity. To prepare learners for an increasingly fluid and interconnected world of work, TVET must evolve into a platform for continuous learning, critical thinking, and inclusive innovation.

2.2 The Current State of TVET in the Global South

Technical and Vocational Education and Training (TVET) systems in the Global South operate within multifaceted and often challenging socio-economic, political, and institutional contexts. Despite their recognized potential to combat unemployment, strengthen human capital, and drive inclusive development, these systems frequently face persistent structural limitations. Issues such as chronic underfunding, weak labor market alignment, and entrenched inequality undermine the effectiveness and reach of TVET across many developing countries (Langthaler & Bazafkan, 2020).

One of the defining features of TVET in the region is its marginal status within national education frameworks. In countries like South Africa, Kenya, and Nigeria, vocational training continues to be viewed as a secondary or remedial option, often reserved for students perceived as low achievers (Allais & Wedekind, 2020). This perception is reinforced by disparities in funding, policy attention, and institutional prestige between TVET and general academic education. As a result, enrollment remains relatively low, and provision is frequently undermined by outdated facilities, inadequately trained personnel, and limited industry engagement (Papier & McGrath, 2020).

Digitalization represents both a challenge and an opportunity. The COVID-19 pandemic laid bare the weaknesses of many TVET systems in adapting to remote and blended learning models. While some institutions in Sub-Saharan Africa and South Asia have piloted e-learning platforms, large portions of the sector lack the digital infrastructure and instructional capacity required to support meaningful virtual learning (Langthaler & Bazafkan, 2020). These disparities risk exacerbating educational exclusion, particularly for learners in rural and informal settlements. As Apelehin *et al.* (2025b) argue, equitable assessment strategies must be embedded into digital reforms to ensure inclusive access and outcomes.

A significant constraint lies in teacher training and workforce development. Zinn, Raisch, and Reimann (2019) observe that many TVET instructors lack exposure to current industry practices and technological advancements, weakening the relevance of training delivery. Educators often operate within rigid bureaucracies that hinder pedagogical innovation and discourage collaboration with

employers. Closing the skills gap between training institutions and labor markets requires investments in continuous professional development, curricular reform, and cross-sectoral partnerships.

Socio-cultural barriers also shape the effectiveness and accessibility of TVET. Gender disparities remain acute, particularly in science, technology, engineering, and mathematics (STEM) fields. Udo and Naidu (2022) highlight how women in flood-prone South African communities face intersecting vulnerabilities, environmental, economic, and educational, which limit their participation in training and employment. TVET systems must be reoriented to address these structural inequities through gender-responsive policies, safe learning environments, and targeted support services.

Geographic disparities further exacerbate exclusion. Rural areas often lack access to well-resourced training centers, and existing institutions are frequently disconnected from local economic ecosystems. Udo and Naidu (2022) advocate for integrating climate adaptation and green skills into vocational training, particularly in ecologically vulnerable communities, to enhance both environmental resilience and socio-economic inclusion.

Institutional weaknesses in governance and accountability compound these challenges. Olinmah *et al.* (2023) suggest that data visualization and performance dashboards can improve transparency, foster internal accountability, and support evidence-based decision-making in educational institutions. However, such tools require robust governance frameworks and decentralization strategies to be effective.

While promising reforms, such as competency-based education, national qualification frameworks, and industry partnerships, are emerging, progress remains uneven. Much of the innovation is donor-driven and difficult to scale due to limited institutional capacity (Papier & McGrath, 2020). Moreover, TVET continues to overlook informal economies, which dominate employment in many Global South contexts. As Langthaler and Bazafkan (2020) note, future reforms must embrace flexible, locally embedded training models that reflect the realities of informal work and community-based livelihoods.

2.3 Key Challenges in Transforming TVET Systems

Efforts to reform Technical and Vocational Education and Training (TVET) systems in the Global South are consistently hindered by deeply embedded structural and systemic challenges. While global consensus continues to emphasize TVET's role in advancing inclusive economic growth, reducing youth unemployment, and promoting climate resilience, translating this potential into practice remains a significant challenge. Governance fragmentation, curriculum inertia, infrastructure deficits, and inequality continue to undermine reform efforts (Allais & Wedekind, 2020).

One of the most pressing issues is fragmented governance. In many contexts, oversight of TVET is dispersed across multiple ministries and agencies, leading to policy incoherence, misaligned mandates, and weak institutional autonomy. As Allais and Wedekind (2020) observe, such fragmentation results in poor implementation, with institutions struggling to operationalize reforms in meaningful ways. A coordinated governance model, one that integrates labor market intelligence, development planning, and educational strategy, is critical to overcoming this gap.

Leadership capacity within TVET institutions also presents a considerable barrier. Tomoh *et al.* (2024) emphasize the importance of visionary, transformative leadership in guiding institutional change, yet many administrators remain embedded in outdated bureaucracies. Ogunwale *et al.* (2024) argue for inclusive leadership approaches that emphasize adaptability, empathy, and participatory governance, essential traits in diverse and fast-changing educational environments.

Curriculum relevance is another persistent concern. Many programs remain disconnected from labor market realities, relying on outdated content that fails to reflect the demands of green economies and digital transformation. Okoli and Appoh (2024) advocate for scalable, inclusive curricula that embed sustainability, entrepreneurship, and digital literacy. Udo *et al.* (2025) reinforce this need by pointing to the lack of alignment between training content and local climate adaptation strategies, particularly for women in vulnerable communities.

Equity challenges are compounded by disparities in access and outcomes based on geography, gender, and socio-economic status. Majola, Rangana, and Geduld (2025) highlight how dominant pedagogical models often reinforce inequality rather than challenge it. Applying Freirean, learner-led approaches, they argue, can empower marginalized groups and foster more inclusive learning environments. Meanwhile, faculty development remains underfunded and underprioritized. Many educators lack exposure to industry practices and professional learning opportunities, weakening instructional quality and institutional innovation (Papier & McGrath, 2020).

Outdated infrastructure presents another major hurdle. As Bakar, Mohamed, and Maskur (2025) note, while some infrastructure improvements are underway, they are typically donor-driven and lack sustainability planning. Without systematic strategies for maintenance and resource allocation, physical deficits will continue to restrict the quality of TVET delivery.

The persistent gap between reform policy and institutional execution remains a central obstacle. Soyeye *et al.* (2025) warn that many reforms emphasize digital tools and performance management without investing in the administrative capacity needed for effective implementation. Digital governance innovations, such as blockchain-based credentialing systems, can improve transparency and efficiency (Afrihyia *et al.*, 2025), but they must be supported by ethical design, data privacy safeguards, and mental health protections in increasingly digital learning environments (Gobile *et al.*, 2025).

Ultimately, TVET reform in the Global South must confront interconnected systemic issues through bold, inclusive, and holistic strategies. Addressing governance, leadership, infrastructure, and equity in tandem is essential for building a future-ready, resilient, and learner-centered TVET ecosystem.

2.4 Modernizing TVET Curricula

Modernizing Technical and Vocational Education and Training (TVET) curricula is essential to bridging the gap between learner competencies and the demands of 21st-century labor markets. As the global economy transitions into the Fourth Industrial Revolution (4IR), many TVET programs in the Global South continue to rely on outdated, industrial-era models that emphasize rote learning and

repetitive skills. This disconnect leaves graduates ill-equipped for the dynamic, technology-driven world of work. As Zancajo and Valiente (2019) argue, curriculum reform must extend beyond content updates to encompass pedagogical innovation, delivery transformation, and inclusivity.

One of the enduring challenges is the persistence of post-industrial curricula shaped by colonial and bureaucratic legacies (Buthelezi, 2018). These approaches often neglect the soft and transversal skills, such as creativity, collaboration, and critical thinking, that are essential for adaptability and lifelong learning. Majola, Rangana, and Geduld (2025) advocate for Freirean, dialogic pedagogies that empower learners to become active agents in reshaping their socio-economic realities.

Digital transformation is a key pillar of curriculum modernization. Tools such as interactive visual analysis platforms (Otokiti *et al.*, 2022), AI-enabled learning systems (Appoh *et al.*, 2025), and micro-credentials offer opportunities to personalize instruction and enhance learner engagement. However, as Appoh *et al.* (2024) highlight, technological integration must be accompanied by institutional cultural change that embraces innovation and collaboration. In this context, teacher development becomes critical. Apelehin *et al.* (2025) emphasize the need for educators skilled in digital pedagogy, inclusive instruction, and student-centered design.

Curriculum evaluation must also evolve. Apelehin *et al.* (2025b) call for assessment frameworks that move beyond standardized testing to include holistic, equitable, and context-sensitive tools. Such frameworks ensure that diverse learners can thrive, regardless of their socio-economic or geographic background.

Curricular reform must also prioritize inclusion. Okoli and Appoh (2024) stress the importance of community-driven, culturally responsive content that reflects local realities while building global competencies. Likewise, embedding entrepreneurship, life skills, and innovation into TVET curricula is vital, especially in contexts where formal employment is limited.

Leadership and governance are central to sustaining these reforms. As Terblanche and Bitzer (2018) caution, curriculum change is inherently political and requires visionary leadership, coherent strategy, and stakeholder alignment. Ultimately, modernized curricula must achieve both employability and empowerment, preparing learners not only for the labor market but also for meaningful, participatory citizenship (Majola, Rangana & Geduld, 2025).

2.5 Industry and Labor Market Linkages

Robust linkages between Technical and Vocational Education and Training (TVET) systems and the labor market are critical to ensuring that education translates into employability, productivity, and economic development. In the Global South, however, such alignment remains inconsistent. Many TVET systems operate in isolation from the rapidly changing demands of the labor market, resulting in persistent skills mismatches, underemployment, and diminished returns on educational investments (Caves *et al.*, 2019). Strengthening collaboration between TVET institutions and industry is therefore vital to keeping training programs responsive, demand-driven, and locally relevant.

A core challenge lies in the insufficient engagement of

employers in shaping training content and delivery. In several African and Latin American countries, the private sector is rarely involved in curriculum development, leading to graduates who lack the competencies required in modern workplaces (Gamble, 2016). Effective reform requires transitioning from a model where education institutions operate in silos to one where training is co-managed with industry stakeholders. Kebede, Asgedom, and Asfaw (2024) emphasize the importance of formal mechanisms such as industry advisory boards, joint curriculum committees, and structured apprenticeships to ensure that training remains aligned with labor market expectations. This kind of structural collaboration, grounded in mutual accountability and continuous data exchange, is essential for closing the gap between training provision and employment outcomes.

Labor legislation plays a complementary role in shaping the interaction between training and employment. Uzougbo *et al.* (2023) highlight how clear and enforceable labor regulations—including protections for new workers, mechanisms for dispute resolution, and contractual transparency—help define the terms of entry into the workforce. In environments dominated by informal and precarious employment, vocational learners benefit from legal literacy, equipping them to navigate employment challenges and protect their rights. Integrating components on labor rights, employment law, and workplace ethics into TVET curricula is a necessary step toward empowering graduates and promoting fair labor practices.

Moreover, sector-specific legal and financial mechanisms must be better reflected in training programs. Sobowale *et al.* (2025) underscore the growing relevance of instruments like retention money bonds in construction and engineering, which carry significant implications for trade-based vocations but are rarely taught in TVET institutions. Incorporating these elements into sectoral training would bridge the gap between technical instruction and real-world commercial practices.

The scope of industry collaboration is also expanding into non-traditional sectors. In healthcare, Mustapha *et al.* (2025) illustrate how community health initiatives are increasingly integrating TVET-trained workers to improve service outreach and impact. Similarly, Imohiosen *et al.* (2025) identify the growing importance of spiritual care and emotional intelligence in health services, advocating for vocational training that reflects this shift. These evolving labor niches point to the need for interdisciplinary training models and curriculum diversification.

As crises such as pandemics and climate-related disasters become more frequent, Soyeye *et al.* (2024) call for the integration of emergency preparedness and resilience training into TVET. This prepares graduates to serve as adaptable frontline workers in times of systemic disruption.

TVET systems must also broaden their concept of labor market engagement, especially in economies dominated by informal employment. As Caves *et al.* (2019) note, successful systems “meet in the middle,” engaging both formal industry and informal networks, including cooperatives, local governments, and community-based organizations. Concurrently, globalization has decentralized skills demand. De Dios Oyarzún and Arellano (2024) highlight the importance of international standards and cross-border mobility, necessitating qualifications frameworks and labor market intelligence systems that allow TVET systems to remain both globally competitive and

locally relevant.

Institutional reform is essential to sustaining these linkages. Many TVET providers lack the governance capacity or financial flexibility to partner effectively with industry. Performance-based funding that rewards graduate employability and employer satisfaction, along with fiscal incentives for industry investment, such as tax rebates or skills levies, can foster a mutually beneficial, performance-oriented TVET ecosystem.

2.6 Driving Digital Transformation in TVET

The rapid global shift toward digitalization presents both an urgent challenge and a transformative opportunity for Technical and Vocational Education and Training (TVET) systems in the Global South. As the Fourth Industrial Revolution reshapes labor markets and learning modalities, many vocational institutions continue to operate with outdated infrastructure, low digital literacy among instructors, and limited access to adaptive technology. In this context, digital innovation must be integrated not as a peripheral initiative but as a foundational component of TVET reform (Grech & Camilleri, 2017).

One of the most impactful developments in education globally is the rise of artificial intelligence (AI) to personalize learning. Apelehin *et al.* (2025) argue that AI enables dynamic content delivery, tailored learning paths, and real-time feedback that address the diverse needs of vocational learners. Appoh *et al.* (2025) further emphasize the power of AI in talent development, including skill diagnostics, retention prediction, and performance enhancement, features well-suited to preparing TVET graduates for agile and evolving labor markets.

Beyond personalization, the use of health data systems offers compelling parallels for education reform. Afrihyia *et al.* (2025), in their review of AI and data analytics in managing non-communicable diseases, highlight how real-time insights can optimize service delivery, resource allocation, and user outcomes. Similar data-driven models could revolutionize TVET administration by enabling predictive tracking of learner progress, adaptive curricula, and resource-efficient management.

Similarly, Merotiwon *et al.* (2025) demonstrate how real-world data in pharmacovigilance improves regulatory responsiveness and safety outcomes. In the TVET context, leveraging real-time performance data can inform evidence-based instructional design, improving both accountability and learner satisfaction. Moreover, Okoli *et al.* (2025) underscore how data equity models, originally developed to expand access to pediatric telehealth, can inform inclusive technology strategies in education. Their framework supports digitally marginalized populations through low-bandwidth solutions, user-centered design, and culturally adapted interfaces, principles that are essential in extending TVET's reach to underserved communities.

Digital transformation in TVET, therefore, is not just about integrating new tools but about leveraging analytics and equity-driven design to build responsive, personalized, and inclusive learning ecosystems that meet the demands of 21st-century work.

2.7 Greening TVET for Environmental Sustainability

As the impacts of climate change, environmental degradation, and resource depletion intensify, Technical and Vocational Education and Training (TVET) systems in the

Global South are increasingly viewed as strategic platforms for advancing sustainability. "Greening TVET" involves embedding environmental literacy, climate resilience competencies, and green technology training into both vocational curricula and institutional operations. Aligned with the Sustainable Development Goals, particularly SDG 4 (quality education) and SDG 13 (climate action), this transformation is no longer aspirational, but essential (Pavlova, 2019).

Greening TVET must go beyond a narrow focus on eco-efficiency or technical training in renewable energy. It demands systemic change that includes pedagogical reform, cross-sectoral policy integration, institutional inclusivity, and the cultivation of environmental awareness. As Owusu-Agyeman and Aryeh-Adjei (2024) argue, green skills are especially critical in informal economies, where employment in sustainable agriculture, recycling, and green construction is growing. However, vocational systems often lag behind these labor market shifts. To bridge this gap, curricula must empower underrepresented groups, particularly youth and women, with the skills to participate in and shape sustainable economies.

Environmental vulnerability reinforces the urgency of this agenda. Udo and Naidu (2023) document how climate-related flooding in South Africa's eThekweni municipality disproportionately impacts women, highlighting the intersections of environmental risk and social inequity. They further emphasize that neglecting climate adaptation undermines long-term development goals (Udo & Naidu, 2022). TVET institutions can play a transformative role by integrating climate literacy, disaster preparedness, and community resilience into training frameworks.

Institutionally, Freimann and Magnus (2023) identify a critical moment for South Africa's TVET sector to mainstream Education for Sustainable Development (ESD). This includes revising curricula and developing metrics to assess integration. McGrath and Russon (2023) support a broader vision that incorporates cultural relevance, community engagement, and lifelong learning.

Implementation remains uneven due to limited funding, governance weaknesses, and fragmented policies. Public-private partnerships (PPPs), as shown by Mustapha *et al.* (2025), offer a solution by enhancing program design and extending reach, principles transferable to green TVET.

Digital tools can also expand access. Jerald *et al.* (2024) highlight successful e-learning pilots in Botswana. Yet, these must be contextualized and supported by infrastructure and training to ensure equity.

Ultimately, TVET must be positioned as a driver of national climate strategies. As Pavlova (2019) and Udo (2020) emphasize, fostering green skills across all levels, from technical to transformative, is key to building resilient, future-ready societies.

2.8 Building Educator Capacity and Professionalization

Transforming Technical and Vocational Education and Training (TVET) systems in the Global South requires a simultaneous transformation of the educators who deliver them. Often operating under severe resource constraints and outdated institutional mandates, TVET educators face structural limitations that hinder their ability to provide relevant, engaging, and future-ready instruction. As Zinn, Raisch, and Reimann (2019) point out, instructors frequently lack industry exposure, access to contemporary teaching

methods, and institutional support. Without addressing the professional development of educators, broader system reforms risk being superficial and unsustainable.

Modern educator development must prioritize inclusive and transformative pedagogical practices. Apelehin *et al.* (2025) emphasize that educational cultures grounded in equity, collaboration, and social responsiveness are critical to fostering organizational growth and workforce adaptability. Their framework underlines that leadership in educational institutions should not only focus on top-down change but also cultivate environments where innovation, diversity, and inclusiveness are valued at all levels. This aligns with Apelehin *et al.* (2025) and others who argue that building inclusive educational ecosystems starts with professionalizing educators through exposure to global leadership practices, inclusive pedagogy, and reflective practice.

Despite policy attention to curriculum reform and infrastructure investment, many governments and institutions continue to underinvest in educator training. Lim *et al.* (2020) call for scalable professional development models that leverage blended learning to reach educators in rural and under-resourced communities. In this context, digital platforms can be utilized for continuous professional learning, peer collaboration, and real-time mentoring. However, the success of these initiatives depends on shifting institutional cultures away from rigid hierarchies and toward communities of practice that encourage innovation and shared ownership of learning.

Organizational culture plays a decisive role in this transformation. Appoh *et al.* (2024) highlight that internal norms, leadership dynamics, and trust-based environments significantly influence knowledge sharing and professional growth. When institutions foster experimentation, mutual learning, and recognition of pedagogical excellence, educators are more likely to engage in reflective and adaptive practices.

The drive to professionalize TVET educators must also include structured career pathways, fair remuneration, and recognition mechanisms. Without these, the sector struggles to attract and retain qualified teaching personnel. Apelehin *et al.* (2025) stress that reforming institutional cultures and leadership development go hand-in-hand with improving teacher status, ultimately building the professional identity necessary for sustainable transformation in vocational education.

2.9 Ensuring Equity, Inclusion, and Gender Responsiveness

Embedding equity, inclusion, and gender responsiveness into Technical and Vocational Education and Training (TVET) systems in the Global South must be treated as a core strategic imperative, not a supplementary goal. These principles are critical for addressing intersecting forms of marginalization, rooted in socio-economic status, gender, disability, ethnicity, and geography, that hinder equitable access to quality education. TVET reform must therefore move beyond a narrow focus on employability to adopt a social justice lens that empowers underrepresented learners and promotes inclusive development (Tikly, Voge & Kurvers, 2020; Wignall, Piquard & Joel, 2023).

Gender inequality remains one of the most pervasive challenges in TVET. Despite policy progress, women, particularly those from rural or economically disadvantaged

backgrounds, continue to face systemic barriers to technical training. These include infrastructural deficiencies, occupational segregation, and gender-biased institutional cultures (Bray-Collins, Andrade & Wanjiru, 2022). Tobias, Alvarez, and Lozano (2024) call for comprehensive reforms, including inclusive curriculum design, mentorship programs, and safe learning environments. Munyi and Cheruiyot (2019) further highlight the importance of tangible measures such as gender-sensitive guidance, female faculty representation, and secure campus infrastructure.

The intersection of gender and environmental vulnerability adds another layer of urgency. Udo and Naidu (2023) document how women in flood-prone areas like eThekweni are disproportionately affected by climate impacts and often excluded from adaptation strategies. Their work underscores the need for vocational programs that embed climate resilience and gender sensitivity. Udo and Naidu (2022) also point to increased risks of gender-based violence during climate disasters, emphasizing the need for TVET curricula to incorporate human rights education, GBV prevention, and psychosocial support systems.

Inclusion must also consider a broader range of marginalization. Leong (2024) advocates for disability-inclusive education models, while Owot *et al.* (2024), Imohiosen *et al.* (2025), and Ukpo *et al.* (2024) stress the importance of emotional and spiritual well-being in vocational training, particularly in health and social service pathways. These models promote holistic inclusion by addressing learners' psychological, cultural, and spiritual needs.

Finally, Udo *et al.* (2025) argue for spatial and symbolic inclusion through culturally responsive content and Africanized pedagogy. Building on this, Wignall, Piquard, and Joel (2023) call for institutional reform that dismantles patriarchal systems and promotes intersectional training for educators. Achieving true equity in TVET requires transforming institutions into safe, inclusive, and empowering environments for all learners.

3. Innovative Financing for Sustainable TVET Systems

Ensuring the sustainability of Technical and Vocational Education and Training (TVET) systems in the Global South is inextricably linked to the diversification, adequacy, and adaptability of financing structures. Traditional dependence on public sector budgets and donor aid is increasingly unsustainable in the face of population growth, digital transformation, and widening socio-economic gaps. Innovative financing strategies are therefore essential to reinforce the capacity of TVET systems to remain responsive, inclusive, and future-proof. These strategies range from public-private partnerships (PPPs) and performance-based funding to Islamic finance, philanthropic engagement, and climate-aligned investment (Palmer, 2024; Kamarzaman & Ahmad, 2025).

A persistent issue in many developing regions is chronic underfunding, which undermines infrastructure renewal, staff development, and alignment with modern labor market needs. Zain and Kamarzaman (2025) point out that the resulting deterioration of TVET institutions impedes their ability to attract learners or maintain relevance in dynamic economic contexts. Beyond increasing funding volume, equitable distribution and transparent utilization are critical, especially for marginalized learners. This resonates with Udo and Naidu's (2023) findings on climate vulnerability

among Black African women in eThekweni, where underinvestment in social infrastructure exacerbates exclusion. These insights stress the importance of financing frameworks that not only support institutions but also address the needs of vulnerable populations.

In response, models such as waqf-based Islamic finance have gained attention for their ethical, long-term, and community-centered potential. Kamarzaman and Ahmad (2025) advocate for embedding waqf into national human capital strategies to fund TVET sustainably in Islamic-majority contexts. These endowment-based approaches can be adapted to support underserved populations, especially women and rural learner groups often overlooked in centralized funding schemes. Udo and Naidu (2022) underscore the systemic neglect of gender-sensitive services during flood crises, illustrating how financing must also support inclusive infrastructure, safety measures, and resilience-building in education.

Public-private partnerships (PPPs) remain instrumental in mobilizing co-investment, enhancing institutional accountability, and aligning TVET with market needs. Amubi and Kipkirui (2023) showcase successful Kenyan models where industry collaboration enhances training quality and employment outcomes. Yet, such models must be rooted in trust, regulatory clarity, and mutual benefit. The integration of inclusive safeguards, particularly for female learners facing intersecting vulnerabilities, is vital. As Udo and Naidu (2023) emphasize, local governments often lack the institutional frameworks to respond to these needs adequately. Financing mechanisms must therefore embed accountability for social inclusion alongside economic performance.

Performance-based financing models are also gaining traction, offering a shift from input-based budgeting to outcome-driven resource allocation. Nungse and Sagbara (2024) caution, however, that overemphasis on measurable indicators such as job placement can unintentionally marginalize learners with greater structural barriers to employment. To mitigate this, equity-weighted metrics and complementary support services must be integrated into funding logic.

Digital innovation is central to redefining cost-efficiency in TVET. As Ganter de Otero (2019) notes, innovation in financing encompasses institutional governance, content delivery, and resourcing. Blockchain-backed credentials, e-learning platforms, and micro-crowdfunding tools provide scalable, secure, and learner-centered financing alternatives. Udo and Naidu's (2023) intersectional analysis of public service gaps further reinforces the need for financing models that extend beyond conventional metrics to account for socio-spatial disparities and intersectional vulnerabilities.

Finally, as Aryal (2020) and Palmer (2024) argue, sustainable TVET financing must be aligned with broader development and climate adaptation goals. This includes integrating green skills development, environmentally conscious infrastructure, and disaster-resilient training environments into financial planning. In flood-affected regions like Durban, Udo and Naidu (2022) highlight how women are disproportionately affected due to infrastructural neglect and policy inattention. Aligning financing strategies with social protection and climate resilience is thus imperative to support equitable, inclusive, and transformative TVET systems.

3.1 Data Systems, Monitoring, and Quality Assurance

Transforming Technical and Vocational Education and Training (TVET) systems in the Global South hinges on the development of robust data infrastructure, comprehensive monitoring and evaluation (M&E) frameworks, and responsive quality assurance (QA) mechanisms. As these systems evolve to include digital skills, green competencies, and inclusive pedagogies, they must also build the institutional capacity to generate, interpret, and act on data related to learner outcomes, institutional effectiveness, and socio-economic impact. Without such systems, reform efforts risk misalignment with ground realities and may fail to deliver equitable, evidence-informed outcomes (Aryal, 2020).

Many TVET systems continue to operate in data-poor environments, characterized by fragmented data collection, inconsistent standards, and limited integration across institutions. As UNESCO (2018) notes, current datasets often focus narrowly on enrollment, neglecting key indicators such as graduate employment rates, skills application, and equity outcomes. This lack of comprehensive data impedes accountability and undermines strategic planning.

Lessons from the health sector offer valuable insights. Afrihyia *et al.* (2024) demonstrate how data analytics in U.S. healthcare have improved resource targeting and policy efficiency—models that are directly applicable to education. Similarly, Merotiwon *et al.* (2025) illustrate how real-time data can support adaptive responses, an approach well-suited to dynamic vocational ecosystems that must rapidly respond to labor market shifts.

Innovative Education Management Information Systems (EMIS) tailored for TVET have shown promise in addressing these challenges. Amubi and Kipkirui (2023) highlight how EMIS platforms facilitate real-time data exchange, track longitudinal outcomes, and support performance-based funding. Tools such as tracer studies further strengthen the feedback loop between training providers and employment outcomes, enhancing relevance and institutional responsiveness.

Quantitative data must be complemented by qualitative insights. Aston *et al.* (2022) stress the importance of capturing learner perspectives, teaching quality, and institutional culture through participatory evaluation. Meanwhile, Okoli *et al.* (2024) advocate for disaggregated, equity-sensitive indicators, vital for identifying and addressing barriers faced by marginalized learners.

Digital tools like dashboards, mobile apps, and learning analytics offer low-cost, scalable solutions. However, Allais (2012) warns that QA systems must be more than procedural checklists; they require embedded accountability, data literacy, and institutional ownership. As Kenya's integration of EMIS with financing demonstrates (Amubi & Kipkirui, 2023), linking data to policy and funding decisions can create powerful incentives for continuous improvement.

Ultimately, M&E and QA systems must serve not only administrative needs but also social, environmental, and developmental objectives, ensuring TVET delivers inclusive, adaptive, and high-impact learning.

3.2 Future Directions and Strategic Priorities

As Technical and Vocational Education and Training (TVET) systems across the Global South confront the

accelerating pace of digitalization, demographic transition, ecological disruption, and labor market evolution, articulating forward-thinking strategies is no longer optional; it is essential. To remain relevant, inclusive, and responsive, TVET systems must move beyond reactive reforms and adopt strategic frameworks that anticipate future challenges and seize emerging opportunities. As Loveder (2021) asserts, future-oriented TVET reform must integrate adaptive planning, participatory governance, and innovation in both delivery and financing mechanisms to build agile, resilient, and equitable systems.

A core strategic direction lies in aligning TVET with national development and economic transformation agendas. According to Zancajo and Valiente (2019), sustainable TVET systems must reconcile two interdependent logics: the human capital logic, which focuses on preparing individuals for employment, and the rights-based logic, which emphasizes equitable access and inclusive participation. In highly unequal contexts, these dual imperatives are particularly important. Future reforms must ensure that vocational education is not only a vehicle for labor market entry but also a catalyst for social mobility and justice.

Strengthening governance structures and policy coherence is fundamental to this transformation. Fragmented responsibilities across ministries, agencies, and sectors continue to impede effective implementation. Loveder (2021) highlights the need for robust national governance mechanisms, including multisectoral coordination platforms, skills councils, and qualifications frameworks that bridge education and labor market systems. Integrated data-sharing platforms and institutionalized accountability structures will further improve coherence and responsiveness.

Modernizing curriculum design and pedagogical approaches is another top priority. Keevy *et al.* (2021) propose the introduction of “new qualifications and competencies” (NQC) that reflect the complexity of today’s global landscape. These include digital fluency, environmental awareness, systems thinking, and intercultural competencies. Modular certification, competency-based assessment, and project-based learning will enable learners to adapt continuously across industries and career stages. Moreover, integrating community engagement into learning can localize content and strengthen contextual relevance.

Inclusion must be embedded in every layer of future TVET planning. Witenstein and Iyengar (2023) argue for reforms rooted in the lived realities of marginalized populations, including rural youth, women, displaced persons, and people with disabilities. Inclusive strategies should prioritize flexible delivery modalities such as mobile learning, community-based instruction, and blended platforms that overcome infrastructure and geographic barriers.

Educator professionalization remains a cornerstone of successful reform. As TVET evolves to include emerging technologies and new pedagogical models, instructors must be supported through continuous training, professional recognition, and career development. Keevy *et al.* (2021) underscore the need for dual-role educators who combine industry expertise with transformative teaching capabilities. Additionally, TVET must be central to green economic transitions. Training institutions will play a critical role in equipping the workforce with skills for renewable energy, sustainable agriculture, circular economies, and climate resilience. This will require investment in green

infrastructure, curriculum redesign, and partnerships with green industry sectors (Loveder, 2021; Keevy *et al.*, 2021). At the policy level, fostering localized innovation is key. Lal (2025) points to Nepal’s National Education Policy as a model for enabling decentralized experimentation while maintaining strategic alignment. National systems should facilitate grassroots innovation, monitor outcomes, and scale what works.

Lastly, embedding anticipatory planning within policymaking is crucial. Zancajo and Valiente (2019) advocate for strategic foresight tools, scenario planning, trend mapping, and big data analytics to identify and prepare for future shifts. Investing in labor market intelligence systems and research institutions will enable evidence-based, future-proofed decision-making in TVET.

4. Conclusion

The evolving global landscape demands a reimagining of skills development systems that are inclusive, adaptive, and aligned with emerging economic and societal needs. Throughout this analysis, a compelling case has been made for a holistic transformation of vocational education systems in the Global South. This transformation is not merely about technical reform, but about repositioning skills training as a cornerstone for sustainable development, social equity, and economic resilience.

A key insight from this study is the necessity of strategic alignment between training programs and broader national development goals. Future-oriented systems must integrate labor market intelligence, embrace digital and green competencies, and foster innovation through responsive, modular curricula. Beyond skills acquisition, the role of such systems must expand to cultivate agency, citizenship, and lifelong learning in increasingly uncertain and interconnected environments.

Equity and inclusion have emerged as foundational principles. Structural disparities in access to education, particularly along gender, socio-economic, and geographic lines, require targeted interventions and affirmative policies. Embedding inclusion within policy, pedagogy, infrastructure, and governance is essential to ensure that no learner is left behind in the shift toward modern, relevant, and socially just training systems.

Equally, institutional effectiveness hinges on the professionalization of educators, the development of robust monitoring frameworks, and the strategic use of data to inform continuous improvement. Systems must support educators as facilitators of change and must be equipped to adapt through feedback loops grounded in evidence and accountability.

Financial sustainability remains a critical enabler of reform. A diversified funding approach, leveraging public, private, and alternative sources, can unlock innovation and ensure resilience against fiscal shocks.

In essence, reconfiguring vocational education for the realities of the 21st century involves more than technical adjustments; it is a profound systemic shift grounded in inclusive values, anticipatory planning, and coordinated leadership. With deliberate investment, strong partnerships, and transformative vision, these systems can become powerful drivers of inclusive growth and sustainable futures.

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