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Fostering Digital Inclusion in TVET Teacher Training: Insights from Quadruple Helix Innovation Model

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ABSTRACT
The use of Information and Communication Technology (ICT, hereafter) has permeated almost every facet of human endeavours. In recent times, the world has seen the massive deployment of diverse technologies to facilitate work processes, and this is the thriving strength of the fourth industrial revolution (4IR). Besides, the recent outbreak of the Coronavirus (COVID-19) pandemic exacerbated the situation, as this has led to the discovery of some new technologies in the delivery of goods and services across all sectors, with education as a major beneficiary. However, some educational institutions, Technical and Vocational Education and Training Colleges (TVET, hereafter) inclusive, especially in developing countries remained closed during the lockdown period due to lack of capacity and infrastructure. Hence, this paper taps into the affordances of the multi-stakeholder collaborations framework of the Quadruple Helix Innovation Model to review published articles, policy documents and conference papers among others on possible ways to foster digital inclusion in TVET. Highlights from the review point to the following benefits of multi-stakeholder partnerships namely, collaborative designing and creation of digital policy, access to digital resources and infrastructure, and increased affordability and sustainability of digital inclusion of training programmes. Thus, it was concluded that these highlighted benefits resulting from such collaboration can be translated into the planning and implementation of digital inclusion in TVET.

Keywords: *Digital inclusion; Quadruple Helix Innovation Model; Teacher Training; TVET*

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INTRODUCTION
With the advent of technology, the application of ICT is seen to have pervaded almost every facet of human endeavours. And this forms the foundation for effective implementation of the fourth industrial revolution with respect to the automation of work processes. Besides, the emergence of the Coronavirus (COVID-19) pandemic has acted as catalyst to the discovery of diverse technologies in the facilitation of work processes across different institutions, education inclusive. According to Comi et al. and Falck et al., education has witnessed massive use of ICT in the delivery of its programme over the years, especially in developing countries.[1] The use of ICT in the classroom to improve learning

[1] Simona Lorena Comi et al., "Is It the Way They Use It? Teachers, ICT and Student Achievement," *Economics of Education Review* 56 (February 2017): 24–39, https://doi.org/10.1016/j.econedurev.2016.11.007; Oliver Falck, Constantin Mang, and Ludger Woessmann, "Virtually No Effect? Different Uses of Classroom Computers and Their

outcomes was one of the topical issues discussed in the background of the UNESCO-UNEVOC E-forum.[2] Teaching and learning have also been identified as one of the twelve potential areas for ICT applications in (TVET) according to the United Nations Educational, Scientific and Cultural Organisation (UNESCO) Institute for Information Technologies in Education (IITE).[3]

TVET as an aspect of education as suggested by Wang has evolved from the provision of well-trained basic operators to providing professional knowledge workers.[4] "Central to the aim of skills training is to provide you with practical techniques and competencies based on professional knowledge rather than well-trained basic operators."[5] Having this purpose in mind, the demarcation between education and training or learning has become blurred as it should be.[6] With the advent of ICTs in education, the need to integrate the less emphasised cognitive learning and much stressed psychomotor training needs are now part of the elements of learning as well as education in future programmes.[7] Nevertheless, the emphasis on practical-oriented training remains the focus of TVET programmes across all strata.

From the foregoing, it is believed that when compared with liberal education, and with a consideration on the level of proficiencies that must be divulged, the dependence on trainers with occupational skills alongside theoretical and professional knowledge is high in TVET.[8] Besides, it is argued that having good facilities, effective administration and willing trainees by themselves cannot achieve a good TVET programme without skilled instructors to deliver the training.[9] The complexity of today's workplace has exacerbated the demand for well-trained TVET teachers. Technology infusion through ICT-enabled advanced tools in factories and industries whereby increased production efficiency and effectiveness is achieved through the operation of advanced machines by workers has placed a high call for an all-round trained TVET teacher.[10] Thus, the major concern as far as the TVET training programme is concerned is the provision of skilled instructors,[11] capable of manipulating ICT-enabled tools in the production of quality graduates that are employable in the industry.[12]

Although teaching and learning have been identified as one of the twelve potential areas for ICT application in TVET,[13] the sector has been confronted with fettered access to these forms of technologies in the execution of its training programmes, thereby creating a huge form of digital barriers for the TVET sector. The situation worsened during the outbreak of the COVID-19 pandemic

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Effect on Student Achievement," *Oxford Bulletin of Economics and Statistics* 80, no. 1 (February 2018): 1–38, https://doi.org/10.1111/obes.12192.

[2] UNESCO-UNEVOC E-forum, "What Are the Implications of the ICT Revolution for TVET?," 2013, https://unevoc.unesco.org/fileadmin/user_upload/docs/ICTandTVET_background-note.pdf.

[3] UNESCO Institute for Information Technologies in Education (IITE), "ICT Application in Technical and Vocational Education and Training: Specialized Training Course," 2005, 14. https://iite.unesco.org/pics/publications/en/files/3214643.pdf.

[4] Tsungjuang Wang, "Educational Benefits of Multimedia Skills Training," in *2009 International Association of Computer Science and Information Technology - Spring Conference* (IEEE, 2009), 25–29, https://doi.org/10.1109/IACSIT-SC.2009.67.

[5] Wang, "Educational Benefits of Multimedia Skills Training," 47.

[6] Zurina Yasak and Maizam Alias, "ICT Integrations in TVET: Is It up to Expectations?," *Procedia - Social and Behavioral Sciences* 204 (August 2015): 88–97, https://doi.org/10.1016/j.sbspro.2015.08.120.

[7] Yasak and Alias, "ICT Integrations in TVET: Is It up to Expectations?"

[8] S Ulinfun, "Adequate Human Resources on Learning," *Journal of Educational Administration* 5 (1990): 21–37; Yasak and Alias, "ICT Integrations in TVET: Is It up to Expectations?"

[9] Yasak and Alias, "ICT Integrations in TVET: Is It up to Expectations?"

[10] Prabhat N Jha et al., "Association of Rhizospheric/Endophytic Bacteria with Plants: A Potential Gateway to Sustainable Agriculture," *Greener Journal of Agricultural Sciences* 3, no. 2 (February 2013): 73–84.

[11] Yasak and Alias, "ICT Integrations in TVET: Is It up to Expectations?"

[12] Dagogo William Legg-Jack and Busisiwe Precious Alant, "Stakeholders' Perceptions on the Use of an ICT-Enabled Onboard Diagnostic System Tool for the Teaching of Motor Vehicle Mechanics at Port Harcourt Technical College, Nigeria," *Journal of Studies in Social Sciences and Humanities* 8, no. 1 (2022): 84–97, http://www.jssshonline.com/.

[13] UNESCO Institute for Information Technologies in Education (IITE), "ICT Application in Technical and Vocational Education and Training: Specialized Training Course."

as different TVET institutions across the globe were not operational, even when others managed to switch to remote teaching and learning. According to Hae-Kyeung et al., 126 countries reported that about 90% TVET centres experienced closure, whilst 98% revealed disruption of work-based learning.[14] Consequently, the hindrances to the continuity of TVET programmes during the pandemic-induced lockdown period resulted from a lack of general and technological infrastructure.[15] Therefore, it is on that premise, the present review argues that collaboration between multi-stakeholders remains the panacea to fostering optimal digital inclusion in TVET provision post-COVID-19. Thus, the objective of the review is in three-fold namely, to uncover, firstly, barriers to digital inclusion in TVET; secondly, the collaborative impact of multi-stakeholders in promoting digital inclusion, and finally, the implications of multi-stakeholder collaborations in promoting digital inclusion in the TVET sector.

To achieve the objectives of this review, an exploratory research approach was employed in the analysis of related literature around the theme of TVET, ICT in TVET, digital inclusion, theoretical framework, barriers to digital inclusion, collaborative implications of multi-stakeholders in promoting digital inclusion and the impact of stakeholder collaborations in fostering digital inclusion in TVET.

Technical and Vocational Education and Training

TVET according to Gretch and Camilleri is understood as comprising an educational pathway that involves training and skills development relating to a wide range of occupational fields, production processes, services and livelihoods.[16] It is an aspect of education with the transformative ability to equip young people with skills and competencies that guarantee them livelihood in the world of work.[17] The implication is suggestive that, there is a relationship between the concept of TVET and employability as well as national development.[18] TVET is one of the twelve potential areas of ICT integration in meeting the demands of teaching and learning in the twenty-first-century classroom.[19] ICT is now considered by many governments as a critical component of a responsive, demand driven TVET system tasked with meeting the needs of learners for more flexible individualised training, due to the automation of the workplace.[20]

Information and Communication Technologies in TVET

The integration of ICT in the TVET instruction, Teaching and learning, educators' preparation, curriculum, as well as workshop activities is central to meeting the challenges of the current era, especially due to the emergence of the fourth industrial revolution.[21] Such integration of ICTs is based on the belief that it can enhance the productivity of the TVET sector.[22] ICTs application in TVET transcends technology usage for instructional delivery to its integration into advanced tools in factories

[14] Chun Hae-Kyeung et. al, "Skills Development in the Time of COVID-19: Taking Stock of the Initial Responses in Technical and Vocational Education and Training | VOCEDplus, the International Tertiary Education and Research Database," Geneva, Switzerland, 2021, https://www.voced.edu.au/content/ngv%3A89412.

[15] Hae-Kyeung, "Skills Development in the Time of COVID-19."

[16] A. Gretch and A. Camilleri, "The Digitization of TVET and Skills Systems," 2020.

[17] Rupert Maclean, *Key Issues and Research Challenges for TVET: Bridging the Gap between TVET Research and the Needs of Policy Makers* (NORRAG NEWS, Towards a New Global World of Skills Development, 2011).

[18] Lukman Raimi and I. Akhuemonkhan, "Has Technical Vocational Education and Training (TVET) Impacted on Employability and National Development," *The Macrotheme Review A Multidisciplinary Journal of Global Macro Trends* 3, no. 2 (2014): 129–45.

[19] UNESCO Institute for Information Technologies in Education (IITE), "ICT Application in Technical and Vocational Education and Training: Specialized Training Course."14.

[20] G Ronald Herd and Alison Mead Richardson, "World Report on TVET The Promise and Potential of ICT in TVET," 2015.

[21] Rana Hammad Hassan et al., "ICT Enabled TVET Education: A Systematic Literature Review," *IEEE Access* 9 (2021): 81624–50, https://doi.org/10.1109/ACCESS.2021.3085910.

[22] S. Ghavifekr and S. Yulin, "Role of ICT in TVET Education: Teaching & Learning Amid COVID-19 Pandemic.," *International Journal of Advanced Research in Education and Society* 3 (2021): 119–31, https://doi.org/10.4236/CE.2021.1212222.

and industries, where workers can use advanced machines for the enhancement of productivity.[23] The workplace is technology-driven; hence, there is a need for the TVET sector to be responsive in the production of graduates that meet the dynamic labour force that is technology-oriented.[24] Therefore, the use of ICT-enabled equipment in teaching helps in the improvement of students' acquisition ability. Similarly, its integration into TVET plays a significant role in enhancing vocational students' outcomes.[25] Evidence from a study conducted highlights that effective ICT integration in TVET impacts the economic level of a nation thereby improving the capacity of the future young workforce.[26]

Moreover, the rational use of ICT equipment in teaching helps to improve students' digital acquisition ability; at the same time, it is conducive to the improvement of students' academic performance. Thus, the need for digital inclusion in TVET is inevitable.

Digital Inclusion

The concept of digital inclusion has a multifaceted meaning in literature. Digital inclusion means bringing the knowledge and use of ICT closer to those who do not already have it. From another perspective, digital inclusion is seen as all efforts made to ensure all concerned, especially the most disadvantaged, have access to and use of ICTs.[27] However, Mori argues that there are three dimensions to the definition of the concept namely, as "access," as "basic digital literacy," or as the appropriation of technologies."[28] The first focuses on the distribution of goods and services to guarantee access to infrastructure and ICTs. The second dimension focuses on basic ICT skills, which allow the individual to make use of these technologies; and, in this case, both access to physical means and academic literacy are the necessary requirements for it. The third dimension adds a step to so-called basic digital literacy: more than knowing how to use ICTs, individuals must develop an understanding of the new means that enables them to "own" these resources, "reinventing their uses, and not being mere consumers."[29] This implication is that digital inclusion means access to dependable internet at adequate speeds, digital devices that meet the users' needs, digital skills training, technical support, and content, apps, and software that are "designed to enable and encourage self-sufficiency, participation and collaboration."[30] However, due to infrastructure, broadband, ICT literacy and data cost among others, educational institutions, especially in the African continent have suffered drawbacks in the integration of digital technologies in the teaching and learning process.[31]

Theoretical Background

This review is framed using Quadruple Helix Innovation Model (QHIM, hereafter). The composition of the model is a mode of collaboration that brings together, the state, educational institution, enterprise and citizens working in synergy in the accomplishment of objectives outside the reach of what a particular entity could do in isolation.[32] QHIM is an advancement of the Triple Helix Model that

[23] N Jha et al., "Association of Rhizospheric/Endophytic Bacteria with Plants: A Potential Gateway to Sustainable Agriculture."
[24] Herd and Richardson, "World Report on TVET The Promise and Potential of ICT in TVET."
[25] Ghavifekr and Yulin, "Role of ICT in TVET Education: Teaching & Learning Amid COVID-19 Pandemic."
[26] Ghavifekr and Yulin, "Role of ICT in TVET Education: Teaching & Learning Amid COVID-19 Pandemic."
[27] National Digital Inclusion Alliance, "Definitions," 2017.
[28] C.K. Mori, "Public Policies for Digital Inclusion in Brazil: Institutional Aspects and Effectiveness in Federal Initiatives for the Dissemination of Telecenters in the Period 2000-2010," 2011.
[29] Mori, Public Policies for Digital Inclusion in Brazil, 40.
[30] National Digital Inclusion Alliance, "Definitions."
[31] Dagogo William Legg-Jack, "Digitalisation of Teaching and Learning in Nigeria amid Covid-19 Pandemic: Challenges and Lessons for Education 4.0 and 4IR," *PONTE International Scientific Researchs Journal* 77, no. 10 (2021), https://doi.org/10.21506/j.ponte.2021.10.10.
[32] Martin Curley and Bror Salmelin, *Open Innovation 2.0;a New Paradigm.* , Innovation, Technology, and Knowledge Management (Cham: Springer International Publishing, 2018), 13, https://doi.org/10.1007/978-3-319-62878-3.

captures the role played by civil society.[33] Emphasis in the QHIM is placed on the resources of information that flow amongst the social subsystems, thus, impacting innovation and competencies in a society.[34] Accordingly, knowledge trade-offs and transmission in this model take place amongst the various stakeholders involved. The implication is that the QHIM thrives on the strength of multi-stakeholder collaborations in achieving its aim.

Multi-stakeholder Collaboration (MSC, hereafter) is a joint approach to governance that incorporates several partners, such as civil society, governments, international organisations, media, and academic or research institutions in sharing their perspectives, information, technology, and financial resources to find out a shared solution.[35] This type of partnership arrangement is required when there is a need to tackle complex problems that are beyond an individual organization.[36] MSC is a partnership arrangement involving public, private and civil organisations that are established based on the strengths of each partner that best meets clearly defined public needs for services, infrastructure, or developmental activities through the transfer of resources, risks and rewards between them.[37] Hence, in driving the needed digital inclusion, there is an urgent need for collaboration between stakeholders from different sectors.

The rationale that underpins the choice of this framework hinges on the objectives of the review carried out in this paper, which focuses on the collaborative strength inherent in multi-stakeholders. Thus, the application of this framework in promoting digital inclusion will yield positive output within the TVET sector. It is believed that the issue of digital inclusion should not be handled by a single institution but in collaboration with organisations from other sectors. Hence, the application of this framework in this review will cater for the missing link that contributes to barriers to digital inclusion within the TVET sector.

METHODOLOGY

As mentioned earlier, the objectives of the review include uncovering the barriers to digital inclusion in TVET; highlighting the collaborative impact of multi-stakeholders in promoting digital inclusion, and finally, the implications of multi-stakeholder collaborations in promoting digital inclusion in the TVET sector. To achieve the objectives of this review, an exploratory research approach was employed in the analysis of related literature around the themes; ICT in TVET, digital inclusion, theoretical framework, barriers to digital inclusion, collaborative implications of multi-stakeholders in promoting digital inclusion and the impact of stakeholder collaborations in fostering digital inclusion in TVET. The implication is that the findings made in this review were based on the consultation of secondary sources of data.[38] The purpose of exploratory research is not to draw conclusions on existing problems but to offer insights on areas or subjects that little or nothing has been done to prepare grounds to investigate the possibilities of undertaking a particular research study.[39]

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[33] Loet Leydesdorff, "The Triple Helix, Quadruple Helix, …, and an N-Tuple of Helices: Explanatory Models for Analyzing the Knowledge-Based Economy?," *Journal of the Knowledge Economy* 3, no. 1 (March 18, 2012): 25–35, https://doi.org/10.1007/s13132-011-0049-4.

[34] Elias Carayannis and Evangelos Grigoroudis, "Quadruple Innovation Helix and Smart Specialization: Knowledge Production and National Competitiveness," *Foresight and STI Governance* 10, no. 1 (March 26, 2016): 31–42, https://doi.org/10.17323/1995-459x.2016.1.31.42.

[35] Md Nurul Momen, "Multi-Stakeholder Partnerships in Public Policy," 2020, 1–9, https://doi.org/10.1007/978-3-319-71067-9_50-1.

[36] Momen, "Multi-Stakeholder Partnerships in Public Policy".

[37] Aidan R. Vining and Anthony E. Boardman, "Public-Private Partnerships in Canada: Theory and Evidence," *Canadian Public Administration/Administration Publique Du Canada* 51, no. 1 (March 2008): 9–44, https://doi.org/10.1111/j.1754-7121.2008.00003.x.

[38] Punyashlok Dash, "Analysis of Literature Review in Cases of Exploratory Research," *SSRN Electronic Journal*, 2019, https://doi.org/10.2139/ssrn.3555628.

[39] Dash, "Analysis of Literature Review in Cases of Exploratory Research"; Ananya Swaraj, "Exploratory Research: Purpose And Process," *Parisheelan Journal* 15, no. 2 (2019): 666–70, https://www.epw.in/journal/2016/46/.../challenge-doing-.

The approach discussed above was employed to review documents, journal articles, newspaper publications, government legislations from both developed and developing countries, reports and dissertations among others. To ensure the validity of the findings in the review, the researchers only considered information from both published and unpublished documents such as peer-reviewed articles, newspaper publications, government legislations from both developed and developing countries, reports and dissertations among others that are relevant to the objective of the paper.

FINDINGS AND DISCUSSION

The debate on the impact of barriers to digital inclusion occupies the center stage in meeting the ideals of the fourth industrial revolution. Discussions on the collaborative impact of multi-stakeholders in promoting digital inclusion in TVET are carried out in the next section.

Barriers to Digital Inclusion

Several factors constitute barriers to digital inclusion. However, four major barriers are reported in this study namely, lack of digital facilities, affordability, digital literacy and lack of the required funds to go online.[40] These barriers are presented in the next section.

Lack of Infrastructure

The absence of the needed infrastructure constitute a major barrier to digital inclusion.[41] According to World Bank, one of these types of barriers is the inability of decision-makers to keep up considering the cost and infrastructure support due to rapid technological developments.[42] Evidence of this has been reported in several studies. In South Africa, it was reported that lecturers' readiness and willingness to apply ICT in the teaching and learning process was impeded by a lack of infrastructure and other systems, thus it was recommended that provision of the necessary equipment to support the application of distance learning be made.[43] For instance, in another study, it was highlighted that lecturers cancel their classes due to load shedding (power outage or the interruption of electricity supply) for lectures that require the use of electricity; thus, this discommoded students.[44] Infrastructure deficiency has also been confirmed in another study as a major problem inhibiting the use of ICT in developing countries. As reported by the study, most times the infrastructure even when provided are inadequate and of poor quality.[45] In Nigeria, such infrastructural issues as lack and poor internet connectivity are challenges confronting the digitalisation of teaching and learning,[46] whilst inadequate

[40] Steve Schmida et al., "Connecting the next Four Billion: Strengthening the Global Response for Universal Internet Access," *USAID, Dial, SSG Advisors.*, 2017.
[41] M. C. Joseph, "The Utilization of ICT by Lecturers in a TVET College in Paarl, Western Cape" (Cape Peninsula University of Technology, 2020).
[42] World Bank, "Remote Learning and COVID-19 The Use of Educational Technologies at Scale across an Education System as a Result of Massive School Closings in Response to the COVID-19 Pandemic to Enable Distance Education and Online Learning (2020) | APCICT/ESCAP," 2020, https://www.unapcict.org/resources/ictd-infobank/remote-learning-and-covid-19-use-educational-technologies-scale-across-education-system-result-massive-school-closings.
[43] N. Mbanga and V.N. Mtembu, "Digital Learning: Perceptions of Lecturers at a Technical Vocational Educational and Training College," *South African Journal of Higher Education* 34, no. 4 (September 2020), https://doi.org/10.20853/34-4-3656.
[44] Thembelihle Gugulabasha Ndlovu, "Technical and Vocational Education and Training Students' Experiences with Information and Communication Technologies Integration in Their Inclusive Classrooms" (University of South Africa, 2021).
[45] Heena Choudhary and Nidhi Bansal, "Barriers Affecting the Effectiveness of Digital Literacy Training Programs (DLTPs) for Marginalised Populations: A Systematic Literature Review," *Journal of Technical Education and Training* 14, no. 1 (June 22, 2022): 110–27, https://doi.org/10.30880/jtet.2022.14.01.010.
[46] Iseolorunkanmi Ojo Joseph et al., "COVID-19 Pandemic: Nigerian University Lecturers' Response to Virtual Orientation," *Cogent Arts & Humanities* 8, no. 1 (January 1, 2021), https://doi.org/10.1080/23311983.2021.1932041; Chukwuma Clement Okeji and Juliet Chinedu Alex-Nmecha, "Online LIS Teaching and Learning during COVID-19 in Nigeria: A Study," *Global Knowledge, Memory and Communication* 71, no. 3 (March 3, 2022): 155–73, https://doi.org/10.1108/GKMC-08-2020-0133.

geographical coverage or a large gap between rural and urban areas impacts negatively on intervention training outcomes.[47]

Affordability

One major challenge that impacts digital inclusion in both developed and developing countries is the issue of affordability. As reported by the WEF, there is a usage gap between penetration and coverage, as this is seen in low-income countries, where a monthly broadband subscription costs 12% of gross national income (GNI), far higher than the UN target of less than 2% by 2025.[48] According to the report, the cost of a basic smartphone stands at $150, which is relatively high compared to that of a laptop as this represents more than about 14 months' wages in these low-income countries, and this is considered one of the largest barriers to internet adoption, even where coverage exists.[49] It was also reported that in low-income countries, the ownership of laptops is low at 21%, whilst for middle and high-income it is 57% and 85% respectively, and this constituted a major limitation to remote learning during the lockdown.[50] Data affordability to download educational videos was reported as a challenge for middle-income economies such as Nigeria, due to its high cost.[51]

Lack, or Limited User ICT Competences

It is believed that lack, or limited user ICT competence constitutes a barrier to digital inclusion. ICT competence or digital literacy is a set of skills, knowledge and attitudes required in the use of digital devices to execute tasks such as problem-solving, information management, and collaboration with respect to effectiveness, efficiency and ethics.[52] Besides, Agwuocha declared that these skills involve being experienced in the critical use of ICT and information technology skills such as the capacity to identify and effectively use diverse technological gadgets to navigate the digital space as well as the mastery of locating, identifying and evaluating the relevance and authority of digital content within the digital space.[53] The use of YouTube in teaching and learning is one example of required skills that is vital for innovation, personal growth and social development.[54] Both teachers and students can employ ICT to equip themselves for the dynamic labour market demands and survival skills required today.[55] However, it has been reported that, beyond literacy abilities, most adults in low- and middle-income countries do not have even basic digital skills and competencies.[56] Across Africa, seven in ten

[47] Sammia Poveda, "A Psychosocial Analysis of Development Outcomes: A Digital Literacy Case Study in Myanmar," *International Development Planning Review* 40, no. 3 (June 2018): 273–97, https://doi.org/10.3828/idpr.2018.12.
[48] World Economic Forum, "Accelerating Digital Inclusion in the New Normal," 2020, https://www3.weforum.org/docs/WEF_Accelerating_Digital_Inclusion_in_the_New_Normal_Report_2020.pdf.
[49] World Economic Forum, "Accelerating Digital Inclusion in the New Normal," 2020.
[50] World Economic Forum, "Accelerating Digital Inclusion in the New Normal," 2020.
[51] Thelma Obiakor and Adedeji Peter Adeniran, "COVID-19: Impending Situation Threatens to Deepen Nigeria's Education Crisis," 2020, https://www.africaportal.org/publications/covid-19-impending-situation-threatens-deepen-nigerias-education-crisis/; Legg-Jack, "Digitalisation Of Teaching And Learning In Nigeria Amid Covid-19 Pandemic: Challenges And Lessons For Education 4.0 And 4ir."
[52] Anusca Ferrari, "Digital Competence in Practice: An Analysis of Frameworks" (Luxemburg- Spain, 2012), https://doi.org/10.2791/82116; Clever Ndebele and Munienge Mbodila, "Examining Technology Acceptance in Learning and Teaching at a Historically Disadvantaged University in South Africa through the Technology Acceptance Model," *Education Sciences* 12, no. 1 (January 14, 2022): 54, https://doi.org/10.3390/educsci12010054.
[53] Ugomma Anaekperechi Agwuocha, "Education Beyond COVID-19: Challenges and Opportunities of Digital Learning in Tertiary Institutions in Nigeria.," *Journal of African Studies and Sustainable Development* 3, no. 13 (2020): 2630–7073, https://doi.org/10.13140/RG.2.2.34534.86085.
[54] Fatima Rahim Almoswai and BushraNi'ma Rashid, "The Effectiveness Of Using Youtube Video On Efl Iraqi College Students' Performance In Grammar At Missan University," *People: International Journal of Social Sciences* 3, no. 1 (June 1, 2017): 391–402, https://doi.org/10.20319/pijss.2017.s31.391402.
[55] Joseph, "The Utilization of ICT by Lecturers in a TVET College in Paarl, Western Cape."
[56] UNESCO-UNEVOC E-forum, "What Are the Implications of the ICT Revolution for TVET?"

people who do not use the internet say they just do not know how to use it.[57] Even in Europe, 19% of adults lack literacy skills, and 45% lack the basic digital skills needed to function fully in a modern society.[58]

Hence, as argued by some scholars, one major way to tackle the barriers to digital inclusion, especially in Africa is through collaboration and partnership between various stakeholders in the establishment of proper policy, legal and institutional frameworks.[59] Therefore, the review employs the affordances of the QHIM to review the impact of multiple stakeholders in fostering digital inclusion in TVET.

Collaborative designing and creation of digital policies

In fostering digital inclusion in any given nation, the government plays a key stakeholder role. The development of a strategic and sustainable digital framework is imperative in fostering digital inclusion, and this is the responsibility of the government as policymakers.[60] In time past, the absence of government policy on bridging the digital divide has created enormous problems. The role of the government extends from creating an enabling policy environment that provides for digital inclusion. According to the World Economic Forum, providing for digital inclusion calls for government-led actions such as setting up a conducive regulatory environment; digitising government services; and incentivizing digital transformation of key sectors through loans, grants, and funds. Others include launching all-inclusive national digital strategies across key sectors such as education, health, energy, agriculture, commerce, etc. and ensuring joint governance between ICT authorities and specific sector authorities and appointing a Ministry for Digital Affairs among others. The responsibility of the government is to foster digital inclusion which cuts across many facets.[61] There is a great need to promote wide access to ICT infrastructure as well as its affordability, improve upon digital competencies and literacy alongside the improvement of the significance and responsiveness of the affordance of being online.[62] Besides, it is also the duty of the government to ensure that persons within the disadvantaged and vulnerable groups who are caught in the web of digital inclusion are catered for, by identifying and amending exclusionary policies and systems, raising the consciousness of digital inequality, combating stereotypes through more images of underprivileged and vulnerable groups in the digital realm.[63] For instance, in different nations of the world, the government puts types of machinery in place that foster digital inclusion. Such policies as Smart Nation for Singapore, the creation of Digital policy in Canada, Digital Economy for Malaysia, China internet plus, and industry 4.0 are national strategic initiatives from the German government aimed at driving digital manufacturing.[64]

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[57] World Bank, "World Development Report 2016: Digital Dividends," 2016, https://www.worldbank.org/en/publication/wdr2016.

[58] OECD, "The Survey of Adult Skills: Reader's Companion, Second Edition, OECD Skills Studies," 2016, https://www.oecd.org/publications/the-survey-of-adult-skills-9789264258075-en.htm.

[59] Sharon C. Waswa et al., "Going Digital Is No Longer an Option: Addressing Barriers to Digital Inclusion in Africa," Youth Transforming Africa, December 17, 2021, https://blogs.worldbank.org/youth-transforming-africa/going-digital-no-longer-option-addressing-barriers-digital-inclusion.

[60] University of Washington Technology & Social Change Group (TASCHA) & International City/ County Management Association (ICMA) Institute of Museum and Library Services (IMLS), "Proposed Framework for Digitally Inclusive Communities" (Washington, DC, 2011).

[61] World Economic Forum, "Accelerating Digital Inclusion in the New Normal,"10.

[62] I. Deganis, P. Zohouri Haghian, and M. Tagashira, "Leveraging Digital Technologies for Social Inclusion. Policy Brief No. 92" (United Nations Department of Economic and Social Affairs. Retrieved from …, 2021).

[63] Deganis, Zohouri Haghian, and Tagashira, "Leveraging Digital Technologies for Social Inclusion."

[64] Deloitte, "Insights about Digital Transformation and ICT Opportunities for Brazil Report and Recommendations," January 2019, https://www2.deloitte.com/br/en/pages/technology-media-and-telecommunications/articles/insights-sobre-o-setor-de-tic---deloitte-brasil.html.

However, the government cannot do this alone, but there is need for a collaborative policy legislation to cater for digital inclusion. Due to the complexities involved in digital inclusion, there is a need to engage policy practitioners from diverse sectors namely, public, private and civil to ensure the legislation of a collaborative framework.[65] By co-designing and co-creating policies with marginalised and vulnerable groups, governments can better identify and address their situation and context-specific vulnerabilities and needs. Such multi-stakeholder partnerships are also important for fostering innovative and agile solutions to address the complex and evolving needs of vulnerable groups, notably in emergency situations as posed by the COVID-19 pandemic.[66] Also, collaboration among stakeholders creates room for legislation for the sustainability of digital inclusion. Thus, such collaborations give birth to the development of a digital inclusive policy that goes beyond handling barriers to some aspects of digital inclusion,[67] to also care for other digital challenges relating to empowerment, opportunities, equity, and excellence.[68]

Access to Digital Resources and Infrastructure

Each of the stakeholders has a role to play in creating access to digital inclusion. For instance, academic or training institutions, as designated venues where people receive education provide access to resources and services. As reported in a study by Broadband Commission (BC), a school or training institution provides a safe environment for the installation of digital equipment for teaching and learning.[69] Accordingly, training institutions can only become the hub of knowledge, prosperity and sustainable development through the provision of internet connectivity which is the basis for digital inclusion.[70] From the study conducted by Broadband Commission, it was concluded that, training institutions through online connectivity affords learners, trainers and administrators access to new resources and pedagogical tools, state-of-the-art knowledge and instruction methods together with new trends in administrative processes as well as teacher training.[71] Often, access to these resources and services is hindered due to certain barriers. A study reported that one approach to fostering digital inclusion is to lower every barrier to its access.[72] The industry as a private sector occupies center stage in promoting digital inclusion. Private sector internet services providers can provide internet services to educational institutions in developing areas at reduced rates.[73] Besides, the private sector of the economy could as part of their social responsibilities make provision for funding or monetary donations to cater for ICTs or donate digital or electronic devices for schools in developing areas, in addition to creating innovative solutions that guarantee access to such services.[74]

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[65] A. Bianchi et al., "Revisiting EInclusion: From Vision to Action. Sevilla, Spain: European Commission, Joint Research Center (JRC)," *Institute for Prospective Technological Studies (IPTS)*, 2006.

[66] Deganis, Zohouri Haghian, and Tagashira, "Leveraging Digital Technologies for Social Inclusion. Policy Brief No. 92."

[67] I. Marien and L. Van Audenhove, "Towards a Multi-Stakeholder Approach for Digital Inclusion. A Case Study of Ghent's Digitaal Talent Policy Program," in *IAMCR Conference 2012 Durban* (Durban: International Association for Media and Communication Research, 2012), 95–96.

[68] Melanie Heeley and Leela Damodaran, "Digital Inclusion: A Review of International Policy and Practice," *Loughborough University*, January 1, 2009, https://www.academia.edu/952389/Digital_Inclusion_a_review_of_international_policy_and_practice.

[69] Broadband Commission, "The Digital Transformation of Education: Connecting Schools, Empowering Learners - Broadband Commission," 2020, https://www.broadbandcommission.org/publication/the-digital-transformation-of-education/.

[70] Broadband Commission, "The Digital Transformation of Education."

[71] Broadband Commission for Sustainable Development, *The Digital Transformation of Education: Connecting Schools, Empowering Learners*, 2020.

[72] Marien and Van Audenhove, "Towards a Multi-Stakeholder Approach for Digital Inclusion. A Case Study of Ghent's Digitaal Talent Policy Program."

[73] Tanya Calitz, "The Right to Education: A Case for Digital Inclusion ," Human Rights Pulse, 2022, https://www.humanrightspulse.com/mastercontentblog/the-right-to-education-a-case-for-digital-inclusion.

[74] Calitz, "The Right to Education: A Case for Digital Inclusion."

Increased Affordability

While the access and quality aspects of digital inclusion are supply-side factors, the affordability of the internet is a demand-side constraint.[75] Therefore, affordability is an essential component alongside both the extensive and intensive margins of internet use.[76] Hence, a collaboration between strategic partners will cushion the effect of the affordability of digital resources and services. According to Bosc et al., one major way to foster digital inclusion is to deregulate the telecommunications industry and develop a friendly environment for the excellence of digital services at the lowest level to foster multiple applications and encourage the usage of internet and ICT in the creation and addition of values to the society.[77] Also, the institution of regulatory policies that cater for internet service provision at considerable rates to cut down the cost of exorbitant charges on data from telecommunication industries can increase the affordability of digital services.[78] Another mode to create access is to invest in actions, policies, and regulations to reduce the cost of resources.[79] These include facilitating synchronisation of infrastructural development across players to optimise construction costs, provide low-cost access to small cell deployment sites, for example, on public property, reduce ICT services and equipment taxes to lower cost to consumers and review sector-specific taxes that affect the affordability of resources, including on equipment import, deployment of satellite receivers among others.[80] Also, it gives room for the harnessing of the private sector's expertise efficiencies and network infrastructure as well as reducing the cost of delivering services, as resources are shared between the various stakeholders involved in the partnerships.

Sustainability of Digital Inclusion in programmes

In driving the sustainability of digital inclusion in programmes, partnerships with strategic stakeholders can facilitate long-term investment in capital for digital development. Every stakeholder in the partnership arrangement with its unique needs and ability aids the achievement of the organisational optimal strategic impact. It is argued that the involvement of stakeholders who are primary consumers of the services is top at sustaining digital transformation.[81] The sustainability of diverse digital applications is highly unlikely to succeed on its own.[82] Hence, there is a need for ongoing coaching, mentoring, training, and knowledge sharing to ensure that all those who will interact with the system have an understanding of how to maximise usage.[83] Thus, Bukit reported that collaboration, especially with the industry offers TVET institutions access to new technologies and new standards applicable to industrial production.[84] So, enabling more persons with greater insight into

[75] Matthew Sharp, "Revisiting Digital Inclusion: A Survey of Theory, Measurement and Recent Research" (Oxford, UK, April 1, 2022), 9. https://doi.org/10.35489/BSG-DP-WP_2022/04.
[76] Pedro Bessone, Ricardo Dahis, and Lisa Ho, "The Impact of 3G Mobile Internet on Educational Outcomes in Brazil," Technical Report, Working Paper., 2020.
[77] R. Bosc et al., "Digital Infrastructure: Overcoming Digital Divide in Emerging Economies," G20 Insights, 2017, https://www.g20-insights.org/policy_briefs/digital-infrastructure-overcoming-digital-divide-emerging-economies/.
[78] Guy Thurston Hoskins, "Beyond 'Zero Sum': The Case for Context in Regulating Zero Rating in the Global South," *Internet Policy Review* 8, no. 1 (March 31, 2019), https://doi.org/10.14763/2019.1.1392.
[79] World Economic Forum, "Accelerating Digital Inclusion in the New Normal."
[80] World Economic Forum, "Accelerating Digital Inclusion in the New Normal,"15.
[81] Allan Watton, "5 Tips to Quickly Get Your Stakeholders on Board with Digital Transformation," 2022, https://www.bestpracticegroup.com/5-tips-to-accelerate-digital-transformation-and-value-via-stakeholder-engagement/.
[82] Watton, "5 Tips to Quickly Get Your Stakeholders on Board with Digital Transformation."
[83] Watton, "5 Tips to Quickly Get Your Stakeholders on Board with Digital Transformation."
[84] Masriam Bukit, "Strengthening TVET Teacher Education: Report of the UNESCO-UNEVOC Online Conference," UNESCO Digital Library, 2012, https://unesdoc.unesco.org/ark:/48223/pf0000222922.

new digital competencies through collaboration with strategic partners equips more minds with problem-solving skills to tackle whatever challenge that emanates from the digital process.[85]

Implications of Stakeholder Collaborations in fostering digital inclusion in TVET

With the outbreak of the COVID-19 pandemic, so many TVET institutions across the globe were closed for several reasons including for lack of the needed infrastructure and skills among others to participate in remote instruction. A major lesson learnt from the outbreak of the pandemic is the massive deployment of diverse technologies in the execution of several tasks across various sectors, education inclusive. In so many nations across the globe, the continuation of educational programmes was based on the availability of ICT infrastructure. For developed nations, this was not much of a challenge, as these measures have been in partial existence before the global lockdown. However, for developing nations, the issue of digital exclusion became pronounced as educational institutions that could not switch from face-to-face to remote learning due to the unavailability of the necessary resources remained closed.[86] Consequently, to meet the demand for resources, cooperation between stakeholders has proven to be beneficial to the sustainability of various organisations.[87]

Therefore, from the benefits accruable on MSC as highlighted in the review above, fostering digital inclusion in TVET demands a robust collaboration amongst concerned multiple stakeholders in policy legislations that will cater for access to digital resources and infrastructure, sustainability of digital programmes as well as increased affordability of digital equipment and services. This approach demands holistic harnessing of resources from various partners involved for the shared benefits of all concerned. The implication is that digital inclusion leads to the booming of the "new economy", in which transactions are executed in an extremely efficient fashion: highly automatic without human input, and at low cost.[88] This is at the heart of QHIM, as it advocates for collaboration in delivering the solution which is difficult for an individual organisation to achieve.

Nevertheless, to cater for the negative impact of the introduction of technology-powered machines in the workplace and wealth distribution, there is a serious need to invest in education in TVET especially, through MSC.[89] This is because, a well-educated worker in a modern economy needs proficiency in such skills as problem-solving, critical thinking, learning and reasoning as well as the ability to work in a team, good interpersonal and creativity skills firmly built on basic literacy and mathematics.[90] Also, such a worker is expected to possess technology-related competencies in diverse areas, which range from ICT specialists to basic ICT users, who effectively use mainstream tools needed in their work.[91] As argued by Millington, workers need to be prepared for a career, not just a job and have the ability for life-long learning to adjust and improve their skills to a dynamic work environment, and this requires an increase in online learning for the enhancement of skills across age ranges beyond the formal education system.[92] TVET as an aspect of education is conferred with the mandate to produce graduates for a dynamic workforce. The implication is that to participate

[85] Watton, "5 Tips to Quickly Get Your Stakeholders on Board with Digital Transformation."
[86] Hae-Kyeung, "Skills Development in the Time of COVID-19: Taking Stock of the Initial Responses in Technical and Vocational Education and Training | VOCEDplus, the International Tertiary Education and Research Database."
[87] Momen, "Multi-Stakeholder Partnerships in Public Policy."
[88] Ben Shenglin et al., "Digital Infrastructure: Overcoming the Digital Divide in China and the European Union," 4. November 28, 2017.
[89] Car Benedikt Frey and Michael Osborne, "Technology at Work v2.0: The Future Is Not… | Oxford Martin School" (Oxford, January 26, 2016), https://www.oxfordmartin.ox.ac.uk/publications/technology-at-work-v2-0-the-future-is-not-what-it-used-to-be/.
[90] Kerry A. Millington, "How Changes in Technology and Automation Will Affect the Labour Market in Africa" (Brighton, UK, 2017).
[91] World Bank, "World Development Report 2016: Digital Dividends."
[92] Millington, "How Changes in Technology and Automation Will Affect the Labour Market in Africa."

effectively in the workplace, the 'study of technologies and related sciences' as seen in the definition, is a necessity that can be achieved with sufficient technology integration in TVET.[93] The need for digital inclusion in TVET is triggered by digital innovation, adaptation and acceleration.[94] The development of new technologies (digital innovation) has created new competencies for education, the workplace and societies in general, thereby leading to the need for new skills that enable individuals to adapt to and benefit from these transformations (digital adaptations), as well as revolutions in the nature of education, work and society.[95] Therefore, to meet these demands, collaborations between multi-stakeholders as advocated by the QHIM are non-negotiable.

Limitations of the study

It is very important to highlight the limitations associated with this paper. From the methodological perspective, there is the existence of limitations on how the data used in reaching the conclusions were generated. It is consistent in literature that exploratory research is not conducted to draw conclusions but to point out areas that need to be researched. Based on that, the findings made in this paper are not considered final because its data was generated through secondary sources that did not include primary methods of gathering information such as surveys, interviews, observations and focus group discussions among others. However, from the findings of this review, it is suggested that further studies be carried out at specific educational institutions on the subject considered in this review.

CONCLUSION

The focus of this review was based on the place of multiple stakeholders in fostering digital inclusion in the TVET sector. Basically, the objectives were to uncover barriers to digital inclusion in TVET; the collaborative impact of multi-stakeholders in promoting digital inclusion; and finally, the implications of MSC in promoting digital inclusion in TVET. The paper carried out an appraisal of discourse within the domain of the focus of the review, with the QHIM as a theoretical lens. Findings from the review revealed that the benefits accruable to multi-stakeholder partnerships in fostering digital inclusion include, collaborative designing and creation of digital policy, access to digital resources and infrastructure, increased affordability and sustainability of digital inclusion of training programmes. Thus, it was concluded that these highlighted benefits resulting from such collaboration can be translated into the planning and implementation of a digital inclusion policy framework in TVET.

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[93] Saud Sukri Muhammad et al., "Effective Integration of Information and Communication Technologies (ICTs) in Technical and Vocational Education and Training (TVET) toward Knowledge Management in the Changing World of Work," 2012.

[94] Gretch and Camilleri, "The Digitization of TVET and Skills Systems," 25.

[95] Gretch and Camilleri, "The Digitization of TVET and Skills Systems," 25.

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