JRIIE Journal of Research Innovation and Implications in Education
Center for Research Implications & Practice

Website:www.jriiejournal.com ISSN 2520-7504 (Online) Vol.8, Iss.1, 2024 (pp. 139 - 150)

Triple Helix Model for Retrofitting Technical and Vocational Education Training in Transition to Green Economy in Tanzania

Godfrey G. Moshi[1], Naisujaki S. Lyimo[2], and Erick V. Mgaya[3]
[1]Department of Electrical Engineering, Arusha Technical College
[2]Department of Applied Science and Social Studies, Arusha Technical College
[3]Ministry of Education, Science and Technology (MoEST) Tanzania
Email: godfrey.moshi@atc.ac.tz

Abstract: *Tripartite relationship between academia, industry and the government establishes the simplest and sustainable framework to address challenges in transition to green economy. This paper focus on application of Triple Helix Model to enable the transition to green economy in Tanzania. The aim is to analyze setup of Technical and Vocational Education and Training (TVET) in Tanzania and identify existing collaboration and gaps between the three parties. Strategies to bridge the gaps and strengthen the relation in order to achieve transition to green economy in the country are proposed. The study analyzes key processes for curricula development, training delivery, and industrial linkages in the three main technical institutions in the country: Dar es Salaam Institute of Technology (DIT), Arusha Technical College (ATC) and National Institute of Transport (NIT). Qualitative analysis of the three processes is carried out with the aim of assessing industry and government involvement. Best practices to be adopted in order to address the inevitable transition to green economy are identified. The study concludes that sustainable transition to green economy requires deliberate effort to forge triple helix collaboration between academia, industry and the government. TVET institutions stand at a better position to bridge the existing gaps and broken linkages. However, this requires TVET institutions to consolidate their training and set both long and short term strategies to be implemented with flexibility and some degree of divergence from the business as usual conduct. Monitoring and evaluation plan need to be set in order to continuously assess dynamics and forces affecting collaboration between the three parties.*

Keyword: *Triple Helix Model, TVET, Green Economy, Academia, Industry, Government, Tanzania*

How to cite this work (APA):

Moshi, G. G., Lyimo, N. S. & Magaya, E. V. (2024). Triple Helix Model for retrofitting technical and vocational education training in transition to green economy in Tanzania. *Journal of Research Innovation and Implications in Education, 8*(1), 139 – 150**. https://doi.org/10.59765/taqw8349tyf.**

1. Introduction

Active collaboration between academia, industry and the government is essential strategy toward realizing sustainable transition to green economy in Tanzania. In 2020, the country's economic status changed from the low-income country to a lower-middle income. The change in economic status was achieved in advanced of the target stated in Tanzania Development Vision 2025 (Planning Commission, 1999). However, the challenge at hand is for the country to maintain the economic growth and ensure sustainable transition to a diversified and semi-industrialized economy. To ensure sustainability, it is inevitable to identify and implement appropriate strategies for transition to green economy in the country. Rapid technological changes pose the need for industry and government to realize the potential

and apply results of TVET, local research, consultancy, and innovation projects carried out by academia. Lessons learned from the outbreak of COVID-19, climate related disasters, and their mitigation, show that countries need to acquire capacity to develop or quickly adopt technologies relevant for solving problems in their local context. These increase the necessity of tripartite collaboration between academia, industry and the government. In order to realize the full potential of such collaboration, existing areas of collaboration between the three parties need to be strengthened, gaps and broken linkages need to be identified and rectified. Besides that, new areas where this collaboration can lead to sustainable industrial and social economic development need to be identified and propelled by all three parties.

1.1 Statement of the Problem

Transition to green economy in Tanzania has so far been discussed in aspects of polices, regulation, licensing, and permits. The main focus of scholars is on fossil fuel, pollution, waste management, and deforestation. The country has been implementing various programs with the aim of achieving clean energy for cooking and minimizing energy efficiency gap. Challenges for transition to green economy in Tanzania have not been fully studied. Roles of TVET and effects of inadequate collaborations between academia, industry, and the government, in transition to green economy need to be understood. Model for collaboration between the three parties needs to be identified and studied. This will provide insights to demonstrate effective pathways for achieving sustainable transition to green economy in the country.

1.2 Objectives of the Study

This study aims to demonstrate application of Triple Helix Model for retrofitting TVET in transition to green economy in Tanzania. The study is guided by the following specific objects:

(i). To analyze setup of TVET in Tanzania.

(ii). To identify existing collaboration and gaps between the academia, industry, and government.

(iii). To propose a model for collaboration between the three parties in order to achieve transition to green economy in the country.

2 Literature Review

2.1 The Triple Helix Model

Study on relationship between government, industry and academia, traces its origin to 1967, when Julius, Director of the Netherlands Central Organization for Applied Scientific Research, introduced the concept of a "triangle", implying that all actors in economic development of any country are bound to find balance within the many complicated relationships in the eternal triangle of government, industry and academia (Leydesdorff, 2013). During the same period, McLean et al. (2020) and Sábato and Botana (1970) presented a model on how different sectors should collaborate to support development in a nation. The model, which focused on Latin America, use a triangular relationship to described how government, industry and knowledge production sectors needed to interact in order to deliver development. The study concludes that lack of such triangular relationship between the three players was blocking economic development in the region. Initially studies represented this relationship using spheres as illustrated in Figure 1.

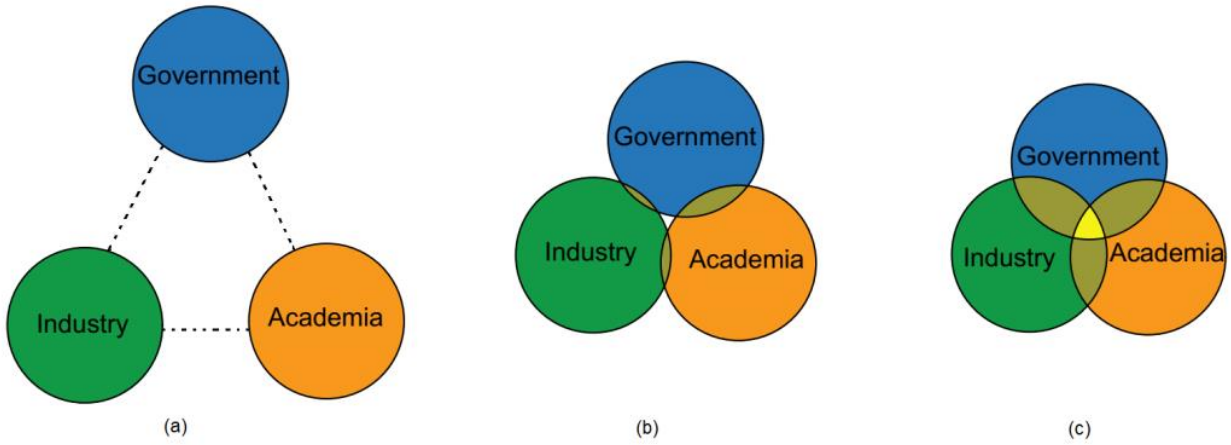

Figure 1

Academia-Industry Government Relations, (a) three actors separate from each other Etzkowitz, 2002a (b) configuration with negative overlap and (c) configuration with positive overlap among the three subsystems

The above concept was officially put into theory by Henry Etzkowitz and Loet Leydesdorff in the 1990s to what is today called the Triple Helix model of innovation (Etzkowitz & Leydesdorff, 1995). These studies show that academia and

industry were operating separately with the govern-ment role to both being dynamic and apparently in contradicting directions. According to these scholars, Triple Helix model is a "spiral model of innovation, which is able to capture multiple reciprocal linkages at different stages of the capitalization of the knowledge". Various studies have argued that the Triple Helix model will be the key strategy of the national or multinational innovation agenda of the 21st century (Razak & White, 2015).

It is important to note that the Triple Helix model has captured a continuous transformation of roles and relationships between the three elements of the models as intertwined spirals with different relations to each other (Etzkowitz, 2008). Considering that spirals are rarely equal, overtime any of the three elements, academia, industry, or the government, may be the driving or the motive force, with the other two spirals acting as ancillary supporting structures. Dynamic of the model indicates that the institution that acts as the core spiral changes over time as one spiral replaces the other as the driving force in a triple helix configuration (Figure 2).

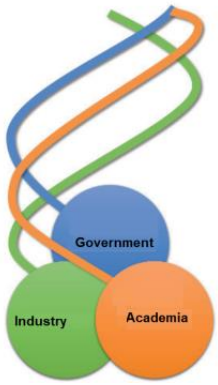

Figure 2
Triple helix model Academia-Industry-Government Etzkowitz, 2002b

In a comprehensive literature review of Triple Helix Model (THM), Cai and Etzkowitz (2020) discuss the past, present and future evolution of theory behind this model. It is shown that changes which the 21st century society has experienced so far will also be reflected in future adaptation and application of the THM. One of the salient features in all the interrelated concepts adopted in this century is concept of *sustainability* which is central to green economy. Finding of above study support work presented in this paper in which we adopt and extend the THM as a framework for retrofitting TVET in transition to green economy.

Several authors have proposed modification or extension of THM in attempt to clarify various debates and issues to be addressed by the model. The Quadruple helix model of innovation added the concept of society and democracy into the basic THM, whereas the Quintuple helix innovation model added into the Quadruple model the context of natural environment of society (Carayannis & Campbell, 2021; Carayannis et al., 2012). Cai (2022) proposed a Neo-Triple Helix model of innovation ecosystems which integrates the triple, quadruple and quintuple helix models. Kusharsanto (2020) found that some forms of modifications in the basic THM are needed in order to properly adopt it into the local context. This paper agrees with above extensions but has adopted the basic THM as relevant model particularly when applied in a new context.

The THM has been applied in various context to evaluate capabilities of innovative environment (Hamid et al., 2019), and to assess development of innovation in various regions of the world (Marina, 2017; Naumova & Sokolova, 2022). Gachie (2020) considered the application of THM for innovation in South-African context. The study found that lack of knowledge on THM among the three actors, conflicting and not unified goals, and exclusion of industry or private sector in the innovation process are the main weakness in adopting the model. Common understanding between the actors is necessary due to the continuous requirement to align the model in response to the evolution and changing needs in the innovation processes. The study concludes that clearly defining the role of each actor, particularly the government, is crucial.

2.2 Green Economy in Tanzania

Green economy refers to a complete economic system that adopts holistic approach to incorporate economic, environmental and social aspects in order to achieve sustainable development. The aim of this approach is to balance economic growth with environmental protection and social wellbeing. Transition to green economy is necessitated by the need to address environmental challenges such as global warming, climate change, depletion of natural resources, and loss of biodiversity while considering the

socioeconomic issues such as inequality, poverty, and unemployment (Söderholm, 2020).

Tanzania has implemented several initiatives in order to realize the transition to green economy. These initiatives include, implementation of seven energy efficiency action plans, strategy for achieving clean cooking energy usage by 2032, and the Southern Agricultural Growth Corridor of Tanzania (SAGCOT). Buseth (2017) examined the implementation of the "green economy" concept in the context of agricultural development, with a focus on the Southern Agricultural Growth Corridor of Tanzania (SAGCOT). The paper explores how the global discourse of the green economy has been integrated into the SAGCOT initiative, presenting it as a form of "green growth" and aligning it with the prevailing trend. The author employs a theoretical framework encompassing discourse institutionalization, governmentality, environmentality, political ecology, and institutional bricolage to analyze the process by which green economy policies are translated into practical initiatives.

Transition to green economy entails adoption of new technologies for improvement of energy efficiency, low carbon technologies, innovative waste management, adoption of modern agriculture technologies to limit expansion of agricultural land into forest land, and cooking technologies alternative to charcoal in order to reduce deforestation (Yang & Yu, 2015). Successive transition to green economy pose a growing demand for green skills throughout all economic sector.

One of the major challenges for transition to green economy is how to introduce green skills in order to upgrade or train new work force which will realize and sustain the transition (UNEP, 2021). It is evident that the transition will introduce death and creation of jobs, new set of skills development, and shifts in labor market. Other challenges for transition to green economy include policy and regulatory frameworks, technological transfer or innovation, financing and investment, behavioral change, social equity, and lack of awareness and education (Fay, 2012).

2.3 Setup of TVET in Tanzania

In Tanzania, TVET is divided into Vocational Education and Training (VET) and Technical Education and Training (TET) (NACTVET, 2022). TET and VET form a ten (10) levels qualification framework consisting of three (3) National Vocational Awards (NVA) and seven (7) National Technical Awards (NTA). VET takes the lowest three levels i.e., NVA level 1 - 3, whereas TET begins from NTA Level 4 - 10 as illustrated in Figure 3. TET provides alternative educational opportunities after secondary school and high school education.

Essentially, TET is part of higher education obtained in a non-university institutions in Tanzania. TET graduates are equipped to play roles requiring higher levels of skill, knowledge and understanding, in which they take responsibility for respective areas of specialization as technicians, associate professionals and professionals, as appropriate. Subsequently, technical and vocation training in Tanzania follows the Competency-based Education and Training (CBET) system which is characterized by ability to carry out an occupational activity.

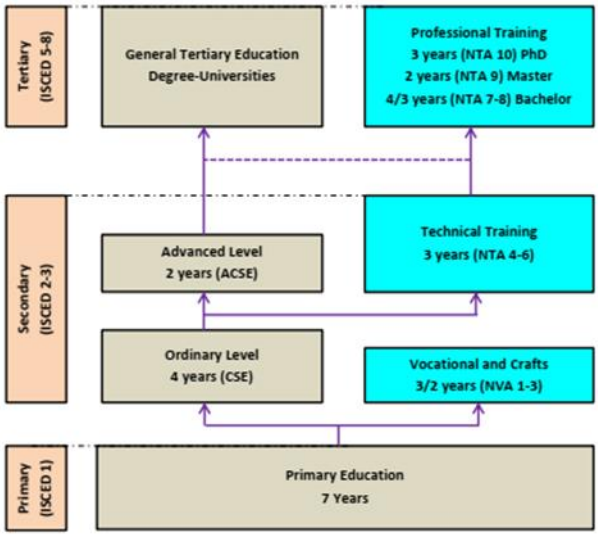

Figure 3
TVET System in Tanzania NACTVET, 2022

National Council for Technical and Vocational Education and Training (NACTVET) is a national body mandated to coordinate and regulate the provision of technical and vocational education and training in Tanzania (The 1997 NACTVET Act, rev.2021, Cap. 129, 2021). The main function of NACTVET are summarized as below:

- To establish and maintain the regulatory framework for technical and vocational education and training, leading to quality assured qualifications.
- To assist TVET institutions to improve and maintain the quality of the education they provide
- To ensure that programs offered by TVET institutions meet labor market demands, by guiding and monitoring their adherence to the regulatory framework.
- To advise the Government on the strategic development of TVET in order to make informed decisions and policies.

TVET is appropriate tool for implementing and promoting sustainable development in Tanzania. The aim of TVET should remain to produce workforce who will be in the forefront in dealing directly with sustainable development issues. In this regard, TVET programmes must aim to enable and expand the acquisition of life skills needed to meet the changing needs of industry and the economy.

However, in order to enhance TVET programme, deliberate effort to address the current challenges facing TVET is is needed (Joseph & Leyaro, 2022; Mihayo & Swai, 2019; MoEST, 2021). These include:

- Strengthen TVET's coordinating mechanisms as regulatory and quality assurance body.
- Harmonization of the TVET programmes offered by the various providers in the country.
- Provision of access for vertical progression in order to ensure a continuation between vocational and technical training.
- Increase and balance financing for TVET programmes in the country.
- Capacity building through long and short term training of trainers, acquisition of training equipment, and allocation of resources and infrastructure.
- Addressing gender issues in TVET subsector to consider marginalized groups such as disabled and women.
- Implement strategies to ensure inclusion of stakeholders (employers, academia and policy makers) in assessing skills mismatch and skills gap in respective fields.

3. Methodology

The study design included three main public technical Institutions in Tanzania namely: ATC, DIT, and NIT. Two to four departments from each of these institutions were involved in this study. Most of these departments offers TET programmes covering all levels, i.e. certificate programme (NVA level 1-3), Ordinary Diploma programmes (NTA level 4-6) and Bachelor Degree (NTA level 7-8). Two of the selected institutions above, DIT, and NIT, offer postgraduate and master programmes (NTA level 9). The duration of programmes for each level is: one year for certificate programme, three years for are Ordinary Diploma programmes, three to four years for Bachelor Degree programmes, and two years for master programmes. Selection of institutions is based on criteria such as: public institutions, size, experience, coverage of most engineering specializations, and number of students should be more than four thousand.

The departments were selected based on the following criteria: (a) size and experience of the department (considered departments which are more than five years since their establishment), (b) levels of the TVET programmes offered by the department (from certificate, diploma, and bachelor or Master level), (c) number of students and gender mix in the programmes should be represented, and (d) different fields of specialization should be represented in the sample (e.g., electrical, civil, laboratory technology, Information and Communication Technologies (ICT), mechanical).

This study used mainly three data collection methods: interview, observation and document analysis. Eight separate but parallel interview schedules were designed for Institute/College Curricula Development Coordinators (CDCs), Industrial Liaison Officers (ILOs), Head of Departments (HODs), secretaries of departmental Curriculum Development Task Teams (CDTTs), members of departmental CDTTs, lecturers and instructors, continuing and graduate students. The interviews included questions on the procedures for curriculum development or review, needs assessment, curriculum validation process, stakeholders involvement, mode of training delivery, adequacy of training equipment materials and workshops, department-industry relations, on-the-job training, assessment of skills and knowledge of graduates, and relevance of the programme curricula to industry or labor market. These questions provided data, from the perspectives of training institutions, on the degree of involvement of industry and government in curricula development, training delivery and collaborations.

Departments in the selected institutions were visited to carry out interviews and observations over a period of two weeks. The researchers spent approximately one day in each department for interviews and observations in laboratory and workshops. The institute ILOs, HODs and secretaries of CDTTs were interviewed individually, and group interviews were carried out with a sample of CDTTs members (approximately three), lecturers and instructors (approximately seven) and continuing students (approximately five) from each programme offered by the departments in each institution. We used continuing students and academic staff to obtain contacts of recent graduates from the programmes in the departments (approximately five). These participants were interviewed individually though phones calls. Table 1 summarizes number of interviewed individuals from the three selected TVET institutions.

Observations were carried out in laboratories and workshops in the selected institutes to critically assess the implementation of TVET curricula. Field notes were taken during observations and interviews. The researchers, right after each interview, went through the interview notes, added and revised them to have more complete descriptions of experiences of the interviewees. The interviews and observations produced a total of 278 pages of field notes (revised). In addition the researchers had access to curricula documents: Situation Analysis Report (SAR), Curriculum Information Report (CIR), Stakeholders Workshop Report (SWR); training documents: module assessment study guides and plan, student Industrial Practical Training (IPT) and project reports which provided additional data for the study.

Table 1: Summary of interviewed individuals

Group	Number of of Interviewees in TVET Institutions			Total
	ATC	DIT	NIT	
ILO[a]	1	1	1	3
HOD[b]	4	4	4	12
CDC[c]	1	1	1	3
CDTT[d]-Secretary	4	4	4	12
CDTT-Members	12	20	12	44
Lecturers/ Instructors	28	28	20	76
Continuing students	28	24	20	72
Graduate students	20	20	16	56

Note.
[a]Industrial Liaison Officer,
[b]Head of Department,
[c]Curricula Development Coordinators, [d]Curriculum Development Task Team

The data produced through interviews, observations and documents were subjected to content analysis. Content analysis involves searching for meaningful phenomena in the data, assigning them descriptive codes and exploring their relations to arrive at themes, and to describe the data as a meaningful whole (Krippendorff, 2018; Miles & Huberman, 1994). First we coded all the field notes to describe the data related to the three processes: curricula development, training delivery, and industrial linkages or collaboration. This was followed by revising all the notes to check each coding in order to establish consistency in the assignment of codes to the same phenomena. Second, the descriptive codes were grouped in categories which fit together meaningfully. These categories allowed to identify the main themes present in the data. Third, by using thematic codes, the whole data were examined again and restructured according to these themes. Then, a third level thematic coding was carried out to determine the general descriptive themes for the data. The thematic coding is used to establish the report structure within which the descriptions and interpretations of the findings were presented.

4. Results and Discussion

The results are organized under three themes viewed from the training institution perspective. These themes describe three process: curricula development, training delivery, and industrial linkages, which were used to study collaboration between the three THM parties. First, the curricula development is critically examined based on the responses of the interviewees, researchers' observations and document analysis. Aspects covered under the curricula development include need assessment, occupational analysis, and green skills gap. Second, assessment of training delivery is carried out for the purpose of identifying existing collaborations and gaps between the three THM parties. Finally, various practices which implement industrial linkages between the TVET institutions and industries are discussed based on the interviews.

4.1 Curricula Development

4.1.1 Needs Assessment

Needs assessment sets the basis for CBET curricula development or review. All CDCs and secretaries of CDTTs indicated that there is a formal guideline provided by regulator, NACTVET, on how to conduct needs assessment and write the need assessment report which is formally known as SAR. In most cases the task involves administering questionnaires and interviews to various groups of stakeholders. The regulator requires the survey to cover all stakeholders in groups: employers, industry, professionals, professional bodies, academic staff, students, and the general society.

All respondents acknowledged the significance of needs assessment in TVET and its role in aligning curriculum with rapidly technological changes and evolving industry demands. On the other hand, students echoed the need for departments to adapt their curricula to the changing workplace requirements. This emphasizes continuous needs

assessment in order to inform curriculum review or development process.

The HODs and CDCs pointed out three main challenges faced by their departments in implementing needs assessment. These include lack of funds to administer the survey, bureaucratic obstacles, and difficult to obtain responses from stakeholders. The interviewees reported several successful needs assessment studies which are results of collaboration between the three THM parties.

On their side, ILOs indicated that the benefits of effective needs assessment include improved curriculum quality, strengthen collaboration between TVET institutions and industry, and makes the programmes responsive to the skills development.

HODs of the departments which offer VET programmes explained that they have not carried out need assessment for VET curricula since these curricula are nationwide developed and reviewed by Vocational Education and Training Authority (VETA) in Tanzania. These HODs complained about the gap between VET curricula and the skills demanded by industry. It seems that VETA is overloaded with the task of updating its curricula and cannot follow technological changes and rapidly evolving industrial needs. The best approach to update or develop demand driven curricula for VET programmes requires coordination by VETA and working in collaboration with instructors and industries in needs assessment.

One concern expressed regarding needs assessment was whether it is appropriate to use similar needs assessment procedures for VET and TET programmes. The respondents considered that VET needs assessment should not take long time as compared to the needs assessment for TET programmes. This came from consideration of the short duration of VET programmes which makes it easier to update such programmes in response to employers and industrial rapid changing environments.

4.1.2 Occupational Analysis

According to NACTVET, occupational analysis is an important stage in curriculum design or review. All secretaries of CDTT explained that the SAR summarizes employers needs, labor market demands, and skills gaps from wider groups of stakeholders in response to the questionnaires for development or review of the curricula. Members of the CDTT teams indicated that they follow a structured and systematic process used in education and training to analyze, design, and develop curricula for specific occupation known as Developing a Curriculum (DACUM).

According to members of most CDTTs teams, DACUM process is conducted by bringing together field experts in a one to two days workshop in order to collaboratively identify key duties, tasks, general knowledge and skills, tools, equipment, supplies and materials, worker behaviors and future trends and concerns in the specific field and level of specialization. The process also involves writing competency statements for each task or duty, describing what a competent worker should be able to do. These statements outline the skills, knowledge, and attitudes required for each task. The validated competency statements serve as a foundation for curriculum development or review.

Few CDCs and HODs reported that they have developed or reviewed curricula without undertaking the DACUM process. The CDCs and HODs agree that the DACUM process ensures close alignment of programme curricula with the needs of industries and job roles. However, they pointed out that due to financial constraints sometimes they are forced to skip the DACUM process. In this case the development or review of curricula rely only on inputs from initial stakeholders' survey documented in the SAR.

Companies sending inexperienced staff for DACUM exercise and time limitations for the DACUM workshop were mentioned as main challenges encountered. Members of the CDTTs teams indicated that some of the field experts are also lagging behind the technological changes which have taken place in their fields thus are not able to propose new changes for update or design of the curricula.

4.1.3 Green Skills Gap

Over half of those surveyed reported that demand for green skills and issues related to the transition to green economy are not explicitly assessed and addressed in curricula design and delivery. Aspects related to the transition to green economy: trends in economic activities, technological changes, and their impact on environmental sustainability are not categorically addressed. Issues related to employment rates, renewable energy, greenhouse gas emissions, pollution, energy efficiency, low carbon technologies, urban planning, climate change, global warming, sustainable transportation and agriculture practices, social equity and inclusion, policies and regulations were found in documentary review and responses from questionnaires and interviews. However, these issues are not viewed in the context of transition to green economy but rather in a broader context of sustainable development. This implies that awareness campaign, training of trainers, and discussions on concepts and relationship between *green economy* and *sustainable development goals* are required. Nevertheless, most of the lecturers, instructors, and students agreed on the necessity to assess needs for green skills, include the needs in curricula design or review, and implement them in the training delivery.

4.1.4 Curricula Design

All CDTTs of the surveyed departments said that curriculum design consists of the actual write-up of CIR which is carried out by all team. This stage involves formulating the purpose of qualification, creating learning objectives, selecting appropriate instructional strategies, designing assessments, and organizing learning materials. The curricula must clearly describe what students will be able to do with what they have learned and represent integration of student's knowledge, skills and understanding in a complex role. This includes incorporation of generic and crosscutting issues to facilitate life-long learning within and across fields.

In response to the format and guidelines for writing the curricula documents, all CDCs indicated that standard format and guidelines are provided by the regulator, NACTVET. They explained that the CIR has three main parts, namely: introduction, qualification standards, and module descriptions. The introduction part consists of programme objectives, rationale, philosophy and description of curriculum structure. Qualification standard part contains the purpose of qualification, learning outcomes, related tasks, assessment methods, assessment instruments, and bench-marking of assessment criteria. The part on module descriptions contains complete description of each module, credits, learning context and materials, references, and mode of assessment.

The CDCs said that after the completion of curricula write-up departments conduct final *Consultative Stakeholder Workshop*, whereby relevant stakeholders from the government, professional bodies, and industries are invited to deliberated and approve the curricula. Evidence of such workshops confirms active collaboration between the three THM parties in curricula design process. Invited stakeholders are required to share their ideas, and confirm that their views obtained during the initial surveys were incorporated in the developed or reviewed curricula. This stage is followed by the validation and approval of curricula by the regulator, NACTVET. It is worth noting that the regulator, NACTVET, conducts final validation by calling again field experts to review the curricula documents and recommend them for any improvement before the final approval by the council.

One of the CDCs insisted that without the collaborations between all stakeholders the development, review and implementation of CBET curricula is impossible. It was further explained that the process is rigorous, costly and time consuming. The respondent added that the process of curriculum development or review as required by NACTVET is participatory and interactive involving different stakeholders: employers, professionals, professional bodies, students, academic staff, and general society. The involvement of various stakeholders in the process provides ownership which enables collaborative delivery of the curricula.

4.2 Training Delivery

Turning now to the delivery of the programme, lecturers, instructors and students indicated the major challenges to be large number of students, inadequate training materials and equipment, and inadequate learning resources such books and ICT services. Lecturers and instructors were concerned with heavy teaching and supervision load which delay assessment feedback and left them with no time to activate engagements and collaboration with industrial experts in the training.

According to the HODs, some lecturers and instructors are traditionally used to implement the curricula following their old style despite the increased weights in practical and hands-on training activities. To address this problem, training of trainers on active learning strategies, development of module study guides and assessment plan, continuous monitoring and evaluation measures are implemented.

Most of the CDCs, ILOs and HODs indicated that they have reflected and acted on feedback collected from trainers, students, graduates, and industry stakeholders in order to make continuous improvements in the training delivery. However, strategies for active collaboration with industrial experts in training delivery need to be identified and implemented. These include invited professional lectures, workshops, professional seminars, and including practicing industrial professionals in training.

4.3 Industrial Linkages

Respondents indicated various ways which are implemented to maintain linkages with industries. All students said that they have spent about two months in field practice through a module called IPT. IPT is one of the modules included in all academic programmes in the surveyed institutions. The main objective of IPT is to provide an opportunity for the students to merge theory and practice while learning and to adopt to the actual working environment. In most cases, the government provides IPT funds directly payable to the students as well as travel and per diem allowances for academic staff to facilitate field evaluation of the students. Companies or industries provide place and technical experts to guide, supervise, and work with students during the placement period. Academic Institutions are responsible for organizing, coordinating and assessing students during the IPT. IPT is one of the best practices which implement the THM, albeit with some challenges.

Some of the interviewed lecturers and instructors reported that they have undergone staff Industrial Attachment Programme (IAP). IAP is considered as on job training for

academic staff in technical institutions. Its main goal is to enable academic staff to have access to authentic experiences that only the industry or field workplace can offer in order for them to replenish and update their skills and thus teach what they have experienced. Normally, IAPs are realized through collaborative partnerships between technical institutions and industries. The interviewed lecturers and instructors acknowledged that IAPs have helped then to blend pedagogical skills and industrial practices and gave them opportunity to register with professional bodies as specialists, consultants, and trainers in their areas of specialization. Eventually, this results in a win-win situation between TVET institution and industries. IAPs is another practice which implements the THM since the government is involved in funding academic staff training.

Lecturers and instructors in the surveyed institutions indicated that field or industrial visits are integral part in the delivery of training. One interviewee presented evidence of field visits plan as per the learning outcomes of the modules in the curricula. The main objective is to give learners opportunities to delve into actual field work, industrial process, and culture. Field visits are organized by students and lecturers or instructors with the aim of realizing specific learning outcome by bringing students face to face with field or industrial realities. This enables the students to directly link what they have learned in class with practices in the field or industrial works such as manufacturing, processing and production.

The CDC and HODs in the surveyed institutions showcased successive plans to couple training with technology incubators, engineering design studio, and entrepreneurship centers. These centers provide space in which students, innovators, entrepreneurs, scientists, technologists, professionals and investors can continuously meet to exchange knowledge, share best practices, develop innovative products, businesses ideas and expand their networks both locally, regionally and globally. DIT has managed to establish one engineering design studio in its main campus in Dar es Salaam. The studio provides a perfect environment for learners to gain skills in prototyping and product development, managing projects, conducting engineering research, as well as entrepreneurship and grant application skills.

ATC and NIT have active entrepreneurship and innovation incubation centers. These centers provide the best environment for collaboration between all the THM parties. Typical example for this case was design of personal protective equipment for healthcare workers during the emerging phase of COVID 19 pandemic. Private and government hospitals, health care providers, businesses, government ministries, and academic institutions, came together to seek cost effective and practical solutions for face masks and sanitizers.

ILOs reported that the surveyed institutions are actively involved in several exhibitions inside and outside the country. Most of these events are organized by the government ministries, agencies, or projects, with the aim of fostering skills development, innovations and research in higher learning and technical institutions. Industries have been among the customers in the exhibition events. Industries are expected to select and develop feasible business ideas or products into a commercialization stage and thus provide employment opportunity to the students. Exhibition events give opportunity for technical institutions to showcase and advertise their work, product and services to businesses, industry and the general public.

The surveyed institutions have well established and experienced Institutional Consulting Bureaus (ICBs). The aim is to offer consultancy services to the community and existing industries, as well as professional development courses for the advancement of local professionals in the field. Often, there is ongoing collaboration between industries and the ICBs particularly due to the huge capacity resulted from the multidisciplinary skills offered by academic staff from the various departments.

HODs reported that their departments have active Memorandum of Understanding (MOU) with government agencies and private companies through which various projects and research have been conducted. These projects and research stems from the problems identified by students during IPT attachment, problems identified through linkage between academic staff and the industry as a result of joint work, or in some cases problems brought by the industries themselves. The ILOs of the surveyed institutions pointed out the establishment of Institutional Companies with the main objective of commercializing products and services emanating from applied research, innovation, and developed/adapted appropriate technology. These Institutional companies have been offering support to other small companies and contractors through various joint ventures agreements. Institutional companies offer win-win and sustainable opportunities for collaboration between academia and industries.

Our documentary review found that none of the departments has specific Programme Advisory Committee (PAC). PAC should consist of experience field experts from industry, government, and businesses related to the programme. The main role of PAC is to advise the departments on design, delivery, evaluation, and review of the programme. Absence of PAC creates a gap and difficulties in forging relationship and linkages with government, companies, business, and industry.

5. Conclusions and Recommendations

5.1 Conclusion

This study set out to demonstrate application of THM for retrofitting TVET in transition to green economy in Tanzania. The study has found that generally the setup of TVET in Tanzania has a clear structure. However, there is a need to separate regulatory and quality control for VET and TET institutions in order to improve efficiency and performance. This will enable NACTVET to quickly respond and implement various policies, regulatory, and control issues directed to TVET in the country.

The findings of this study show that curricula development process, training delivery, and industrial linkages for VET and TET institutions differs significantly and thus need to be structured separately. Likewise, the interaction between the three parties of THM in addressing green skills gaps varies depending on whether the intervention requires short term or long term response. Short term interventions could be efficiently implemented and monitored at VET levels, whereas long term interventions could be implemented at TET levels.

This study identified and elaborated existing collaborations between TVET institutions, industry, and the government in curricula development, training delivery and existing industrial linkages. So far, the major role of the government has been financial support, policy making, and establishment of regulatory body to oversee TVET in the country. This study propose extending the government roles to include implementation of strategic action plans with the aim of activating and strengthening collaboration between TVET institutions and industries.

TVET institutions in Tanzania need to realize the changing industrial needs, government policies and society expectations. In order to realize THM of collaboration, TVET institutions need to set both long and short term strategies that require flexibility and some degree of divergence from the business as usual style of delivering the training. The study shows that currently TVET institutions stand at a better position to bridge the existing gaps between them, the government, and industries. Strategic plan should be implemented in order to strengthen collaboration between TVET and industries. Success in this undertaken is guaranteed only when the win-win situation is arrived and common goals between the two parties are realized.

5.2 Recommendations

This study recommends activation of existing MOUs with industries, working on projects in which both the TVET institutions and industries will benefit, and engagement with industrial experts during curricula delivery through seminars, professional lectures, or workshops. Establishment of PACs with experienced members from industries and the government is highly recommended.

Overall, the study recommends THM as the best model for collaboration between the TVET institutions, industry, and the government in implementing the transition to green economy in the country. Findings of the study presented successful cases in which the three parties are currently collaborating. The three parties in THM stand at the best position to realize the transition to green economy as this process requires policy intervention, training to bridge the existing green skills gap, and collaborative approach with all economic sectors and the society as whole.

References

Buseth, J. T. (2017). The green economy in Tanzania: From global discourses to institutionalization. *Geoforum*, *86*, 42–52. https://doi.org/https://doi.org/10.1016/j.geoforum.2017.08.015

Cai, Y. (2022). Neo-triple helix model of innovation ecosystems: Integrating triple, quadruple and quintuple helix models. *Triple Helix*, *9*(1), 76–106.

Cai, Y., & Etzkowitz, H. (2020). Theorizing the triple helix model: Past, present, and future. *Triple Helix*, *7*(2-3), 189–226.

Carayannis, E. G., Barth, T. D., & Campbell, D. F. (2012). The quintuple helix innovation model: Global warming as a challenge and driver for innovation. *Journal of innovation and entrepreneurship*, *1*, 1–12.

Carayannis, E. G., & Campbell, D. F. (2021). Democracy of climate and climate for democracy: The evolution of quadruple and quintuple helix innovation systems. *Journal of the Knowledge Economy*, *12*(4), 2050–2082.

Etzkowitz, H. (2008). *The triple helix: University - industry - government innovation in action*. Taylor & Francis.

Etzkowitz, H. (2002a). Incubation of incubators: Innovation as a triple helix of university-industry-government networks. *Science and Public Policy*, *29*(2), 115–128.

Etzkowitz, H. (2002b). *The triple helix of university-industry-government: Implications for policy and evaluation*.

Swedish Institute for Studies in Education; Research.

Etzkowitz, H., & Leydesdorff, L. (1995). The triple helix–university - industry - government relations: A laboratory for knowledge based economic development. *EASST review*, *14*(1), 14–19.

Fay, M. (2012). *Inclusive green growth: The pathway to sustainable development*. World Bank Publications.

Gachie, W. (2020). Higher education institutions, private sector and government collaboration for innovation within the framework of the triple helix model. *African Journal of Science, Technology, Innovation and Development*, *12*(2), 203–215. https://doi.org/10.1080/20421338.2019.1631120

Hamid, R., Anwar, S. M, & Lumoindong, Y., (2019). Using the triple helix model to determine the creativity a capability of innovative environment. *IOP Conference Series: Earth and Environmental Science*, *343*(1), 012144.

Joseph, C., & Leyaro, V. (2022). Gender Differential Effects of Technical and Vocational Training: Empirical Evidence for Tanzania. *Journal of African Development*, *23*(2), 294–321. https://doi.org/10.5325/jafrideve. 23.2.0294

Krippendorff, K. (2018). *Content analysis: An introduction to its methodology*. Sage publications.

Kusharsanto, Z. S. (2020). Modifying the triple helix model of innovation: A lesson learned from cimahi techno park in indonesia. *International Journal of Innovation and Regional Development*, *9*(2), 158–175. https: //doi.org/10.1504/IJIRD.2020.110528

Leydesdorff, L. (2013). Triple helix of universityindustry-government relations. In E. G. Carayannis (Ed.), *Encyclopedia of creativity, invention, innovation and entrepreneurship* (pp. 1844–1851). Springer New York. https://doi.org/10.1007/978-1-4614-3858- 8_452

Marina, S. (2017). The triple helix model for regional development and innovation: Context of nordic countries. *Forum Scientiae Oeconomia*, *5*, 5–21.

McLean, R., Tijssen, R., Wallace, M., & KraemerMbula, E. (2020). *Transforming research excellence: New ideas from the global south*. African Minds.

Mihayo, I. Z., & Swai, R. M. (2019). Green economy in tanzania: Is it foreseeable? *Journal of Applied and Advanced Research*, *4*(4), 112–118.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. sage.

MoEST. (2021). *Technical and vocational education and training development programme (tvetdp) 2013/2014 – 2017/2018.* Ministry of Education, Science and Technology (MoEST)-Tanzania. Dodoma.

National Council for Technical and Vocational Education and Training (NACTVET). (2022). Review of tvet policy implementation in Tanzania. *East African Regional TVET Conference*, 1–4. https://www.nacte.go.tz/wp-content/uploads/2022/05/Reviewof-TVET-Policy-Implementation-in-Tanzania.pdf

Naumova, E. A., & Sokolova, E. V. (2022). Regional aspects of the application of the "triple helix" model as a factor in the development of an innovative economy. *Entrepreneur's Guide*. https://doi.org/10.24182/2073-9885-2022-15-4-45-51

Planning Commission. (1999). *The Tanzania development vision 2025*. United Republic of Tanzania.

Programme, U. N. E. (2021). Global guidance for education on green jobs: Connecting higher education and green opportunities for planetary health. https://wedocs.unep. org/20.500.11822/35070

Razak, A. A., & White, G. R. (2015). The triple helix model for innovation: A holistic exploration of barriers and enablers. *International Journal of Business Performance and Supply Chain Modelling*, *7*(3), 278– 291.

Sábato, J. A., & Botana, N. R. (1970). La ciencia y la tecnología en el desarrollo futuro de américa latina.

Söderholm, P. (2020). The green economy transition: The challenges of technological change for sustainability. *Sustainable Earth*, *3*(1), 6.

The 1997 NACTVET Act, rev.2021, Cap. 129. (2021). *United republic of Tanzania (1997). national council for technical education act*. Dodoma: United Republic of Tanzania.

Yang, M., & Yu, X. (2015). *Energy efficiency: Benefits for environment and society*. Springer London.