Assessing the Relevance of Technical Education Curricula to Current Industrial Skill Demands in Tanzania: A Case Study of Civil, Electrical, and Biomedical Engineering Curriculum

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Abstract

This qualitative study assessed the alignment of technical education curricula with current industrial skill demands in Tanzania. Data were collected through documentary review and interviews with 34 purposively selected technical graduates. Thematic analysis was employed to analyse the data. The findings revealed persistent reliance on outdated content delivered predominantly through lecturing methods within certain parts of the curriculum. The study also identified obsolete teaching and learning facilities, such as equipment and machines. Furthermore, it highlighted discrepancies between the stated learning outcomes of the curriculum and NACTVET's CBET standards. These findings suggest a misalignment between the curriculum and industry requirements, potentially impacting graduates' preparedness for the workforce. Consequently, the study recommends a comprehensive curriculum review informed by a rigorous labour market analysis. To facilitate this process, NACTVET could offer training programmes for technical education institutions on developing curricula aligned with CBET standards.

Keywords: *implemented curriculum, learning outcomes, relevant curriculum, teaching and learning facilities, technical graduates*

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Introduction

Tanzania has made significant efforts to promote Technical Education and Training (TET) to equip its graduates with the skills needed in the industrial sector. Several reforms have been implemented to enhance the quality of technical education and its learning outcomes, ensuring the curriculum is aligned with industry requirements. Notably, the Education for Self-Reliance (ESR) reform in 1967 aimed to develop a curriculum that provided practical education to prepare students for industrial work (United Republic of Tanzania [URT], 1996). Additionally, in 1972, the “Siasa ni Kilimo” (“Politics is Agriculture”) motto and the Musoma Declaration on Education for All (EFA) led to the establishment of schools specialising in technical education. These initiatives aimed to prepare paraprofessionals in agriculture, engineering, business, and domestic science, thereby enhancing graduates’ practical skills (Nzima, 2016).

Further, in 1996, a policy on Technical Education and Training was established in order to increase the number of technicians and technologists with skills needed in the industries, as stated in one of its policy statements:

> The need for technical and training policy in Tanzania is guided by four main considerations, namely: to have sufficient trained technical manpower of all categories, to impart technical skills to our youths and adults to enable them to go into sustainable self-employment, inculcate a science and technology culture in Tanzania, improve manpower balance among the technical cadre of engineers/ technologists, technicians and craftsmen from the present national ratio of 1:2:14 leading to the internationally accepted ratio of 1:5:25 (URT, 1996, p. 6).

In 1997, the government established the National Council for Technical Education (NACTE) to manage and coordinate all aspects of technical education and training (NACTE, 2016). In 2000, a significant shift occurred from a Knowledge-Based Education and Training (KBET) system to a Competence-Based Education and Training (CBET) system, aiming to produce graduates with industry-relevant skills (Rutayuga, 2014). Furthermore, in 2014, Tanzania introduced its Education and Training Policy to increase educational opportunities and success rates, thereby producing graduates who meet global labour market demands by 2025 (Ministry of Education Science and Technology [MoEST], 2014). These reforms were largely driven by the Government’s Development Vision 2025, which envisions Tanzania as a nation with a high level of education at all levels, producing a workforce equipped with the knowledge, skills, and attitudes needed to meet local and international labour market challenges (NACTE, 2015).

Currently, the 2014 Tanzania Education and Training Policy, 2023 edition is introduced in the education system so as to improve the provision of education in the country to overcome the shortfalls as identified in the policy document:

> …..however, during the implementation period of this policy (2014) of 2015-2022, the education sector continued to face various challenges that contributed to the decline in the quality of education and training in the country. These challenges include weaknesses in the system and structure of education and training. This system in the 2014 policy focused on providing general education. It lacked various opportunities for education and training based on needs, as well as different ways of learning according to the environment. In addition, curricula at multiple levels of education and training did not meet the needs of economic, social, scientific and technological changes (United Republic of Tanzania [URT], 2023, p. vii).

The above quote from the new 2014 (2023 edition) policy document indicates that Tanzania's curricula are faced with various constraints, hence producing graduates with skills that do not fit the world labour market demands.

As stated above, the delivery of technical education in the country is guided by the 2014 (2023 edition) Tanzania Education and Training Policy, which is geared to implement a competence-based philosophy through the National Technical Awards [NTA] system. In competency-based learning, the emphasis is on education outcomes that are based on performance standards and that should meet the skills required by employers in the labour market (NACTE, 2017). Also, the effective regulation and coordination of technical education and training in the country mandated by the National Council for Technical and Vocational Education and Training (NACTVET) cannot be achieved if curricula for technical institutions do not address the needs of the market demands. Definitely, the curricula for technical institutions should be tailored well in order to address the needs of the current market demands effectively. Thus, every technical education and training institution that follows the NTA system must implement the relevant curriculum. The relevant curriculum, according to Abdulrahman et al. (2019), is a curriculum that is pertinent to the needs of the economy, which produces graduates with the ability and expectation to put their skills into practice, display competence and capability of what was learnt in the curriculum to flow with the expectations of the workplace. Technical education curriculum, therefore, must prescribe its learning outcomes formulated from the labour market analysis in line with NACTVET's Competence-Based Education and Training (CBET) standards to produce graduates with skills that match industrial skills demands (NACTE, 2020).

Tanzania committed itself to becoming a middle-income country by 2025, as envisaged in its Vision 2025, through industrialisation. However, one of the key challenges facing industrialisation in Tanzania is obtaining a labour force with the required skills. This is because the education sector does not produce graduates who match the skills needed in the market (Katabaro & Sumra, 2016). It should be noted that the context in which industrialisation occurs is rapidly changing. Technological advancement within domestic and foreign companies has created a new demand for an increasing number of higher-skilled workers (Ministry of Industries and Trades [MIT] & United Nations Industrial Development Organization [UNIDO], 2012). Large constructions, for example, The Mwalimu Nyerere Stigler's Gorge, Standard Gauge Railway [SGR] and the infrastructure for Phase 3 and 4 of the Dar es Salaam Rapid Transit Bus (DART) cannot be handled without the use of skilled engineers, modern construction equipment and management techniques to reduce time while maintaining the higher standards of construction quality. This means that there are rapid changes in industrial skills demands that should be realised in the curricula. This calls for the current study to assess the relevance of technical education curricula to the current demands for industrial skills in Tanzania.

The government has made several efforts to improve the technical education curriculum to ensure that technical engineering graduates are well-equipped with the requisite skills for industrial demands. This includes establishing various policies and formulating guidelines for curriculum development, which emphasise labour market analysis. However, despite the interventions the government has made, literature has shown that there seems to be a disconnection between the curriculum that students are trained through in tertiary education and the expectations in the world of work. Many employers in Tanzania were still complaining about the existing gap between technical education graduates' skills and industrial skills demands (MIT & UNIDO, 2012; Modu, 2016; MoEST, 2014; NACTE, 2020).

Various studies have examined the problem of the skills gap, predominantly reporting on the general factors contributing to the increasing mismatch between technical education graduates and industry needs (Modu, 2016; Munishi, 2016; NACTE, 2016; NACTE, 2020). These studies highlighted poor infrastructure and an insufficient number of institutions as key challenges hindering the preparation of technical education graduates with the necessary skills for the industry. However, there is limited empirical evidence specifically addressing the relevance of engineering curricula. Against this backdrop, the present study assessed the relevance of the Civil, Electrical, and Biomedical Engineering (CEBE) curricula to current industrial skill demands.

It should be noted that it is the curriculum that decides on the activities, methods, and media to be used in teaching and learning and that gives instructions on how the assessment would be conducted and how its overall effectiveness would be evaluated (NACTVET, 2023; NACTE, 2010). In assessing the relevance of the curriculum, researchers focused on the relevance of the implemented curriculum (contents, methods and resources) to the industrial needs. It also assessed the relevance of the stated learning outcomes of the CEBE curriculum to determine whether they were in line with NACTVET's CBET standards of curriculum development. This study, therefore, sought to respond to the following research questions:

i. What are the graduates' views on the relevance of the implemented CEBE Curriculum in technical education institutions to the demands of industrial skills?
ii. How do the stated learning outcomes of the CEBE curriculum align with NACTVET's CBET standards for curriculum development?

Conceptual framework

The paper is guided by *The Institutions and the Industries Relationship Model* pioneered by Hilary et al. in 2019, which illustrates the existing relationship between industry and technical education institutions in preparing graduates with skills needed for the industries. According to the model, in order to enhance the capacity of technical institutions to deliver training that is responsive to the labour market demands, partnership with the industries is crucial. The forms of partnerships should include collaboration in determining training needs for programmes and curriculum development and review, student internships and funding of the training equipment. The model, therefore, informs the study on the importance of a two-way relationship between technical education institutions and industries in curriculum development, teaching and learning processes in order to produce graduates with skills that match industrial needs. Employers, therefore, must be involved in curriculum development and implementation processes so that technical education institutions produce the needed graduates with skills relevant to the industrial demands. During curriculum development, learning outcomes should be stated based on industrial needs guided by CBET standards.

Methodology

Design and sample

The study adopted a qualitative research approach as informed by a case study research design, specifically the multiple case study design. Cohen et al. (2017) argued that the nature and objectives of the research questions determine the type of research design, methodology, and techniques to be used in the study. The rationale for this choice is due to the nature of the research questions, which demanded an in-depth exploration of social interaction within specific social settings, such as the technical education institutions and industries that employ technical education graduates. Based on that consideration, the choice of the qualitative research approach was appropriate for the current study as it helped to obtain thick and rich data from the participants. In this regard, two (2) technical education institutions offering engineering programmes and

32 industries that are potential employers of the graduates from technical institutions were considered cases of the current study. In addition, the ordinary diploma graduates employed in CEBE industries and technical education curricula were designated as units of analysis, making the study a multiple case.

The study was conducted in the Dar es Salaam and Arusha regions, which were purposively selected. According to the NACTE (2017), these two regions are among the regions with a high number of technical institutions offering engineering programmes. For instance, the Dar es Salaam Region has eight (8) institutions, followed by the Arusha Region with three (3) institutions. Dar es Salaam was also chosen due to the presence of a large number of industries employing technical education graduates as compared with other regions, according to the NBS (2018) report.

Using purposive sampling, specifically the criterion sampling technique, twenty technical graduates from civil engineering programmes and fourteen technical graduates from electrical and biomedical engineering programmes were selected from various technical institutes offering engineering programmes across the country, totalling thirty-four participants. The rationale for this selection is that the civil engineering programme is currently offered through several engineering pathways in the country, as reported by the 2018 National Bureau of Statistics (NBS). Civil engineering is perceived to provide a significant number of job opportunities compared to other industrial activities, suggesting a high demand for civil engineering technicians. Consequently, it was expected to be relatively easy to find currently employed civil engineering graduates with improved skills.

Electrical and biomedical engineering programmes were chosen due to their status as newly established programs with high demands for technological applications and high employment rates among graduates, attributed to the scarcity of biomedical engineering experts in the country (ATC, 2013). The criteria sampling technique was used to select graduates who were currently employed and had no more than three years of work experience. This selection aimed to gather views on the relevance of the implemented curriculum in technical institutions concerning new employment skills requirements. Lists of registered civil engineering industries were obtained from the Engineering Registration Board (ERB) and Contractors' Registration Board (CRB). In contrast, biomedical industries were selected based on data from the Ministry of Health and Social Welfare (2019), which indicates staffing levels for the Ministry's departments, health service facilities, health training institutions, and agencies from 2014-2019.

Additionally, using the criteria sampling technique, two technical institutions (XX and YY) offering civil, electrical, and biomedical engineering programs were selected from the two regions. Criterion sampling ensured that the selected institutions offered these programmes as per the NACTE (2017) report.

Data Collection and Analysis

Face-to-face semi-structured interviews were used to obtain views from ordinary diploma graduates in civil, electrical and biomedical engineering on the relevance of the implemented curriculum in terms of contents taught, teaching/learning methods and training facilities used. The rationale of using an interview is that it follows the qualitative research strategy, which helped to gather in-depth information from the participants as it provides direct contact with participants and collection of original views and provides room for more probing questions in getting detailed information (Creswell & Creswell, 2018; Pesambili, 2021; Pesambili & Mkumbo, 2024). Nine (9) open-ended interview questions were used, and the average time assigned to each participant was approximately 50 minutes. The researchers also used a field notebook and audio recorder to collect data from the participants. The documentary review was also employed to collect data, and the documents reviewed are NTA level 6 curriculum for civil, electrical and biomedical engineering. Researchers used documentary review to assess how the stated learning outcomes of the civil, electrical and biomedical engineering curriculum aligned with the NACTVET's CBET standards set for the curriculum development. Documentary review was helpful as it provided permanent data that other scholars could easily verify.

Data were analysed using a thematic analysis framework proposed by Huberman et al. (2014). Data processing started on the first day of data collection and continued throughout the study. This concurrent approach that combined data collection and analysis made it easy for researchers to reflect on the data and go back to the participants for verification of the data where necessary. Thus, data reduction was possible, and when where necessary, the addition of data could also be achieved. The collected data were processed by field raw data from interviews and documentary review notes, which were transcribed into text to obtain the main ideas (Huberman et al., 2014). Second, the reading and repeating reading in searching meanings and patterns so as to get a general sense of the information followed (Pesambili, 2020). Third, the researcher organised data into meaningful groups, identifying the interesting aspects of the data that may form the basis for the repeated pattern (themes) across the dataset (Pesambili & Novelli, 2021). Fourth, the researcher coded and analysed the data (Huberman et al., 2013; Pesambili, 2020). Descriptive coding techniques were employed to develop codes based on the stated research questions. Subsequently, these codes were combined to form overarching themes by locating and collating text to describe each theme, facilitating reporting in response to the research questions.

Findings and Discussion

This study investigated the alignment between the implemented CBET curriculum in civil engineering (CEBE) and current industry skill demands in Tanzania. Data analysis revealed three key areas where the curriculum deviated from industry needs: outdated content, overreliance on lecturing methods, and obsolete teaching/ learning facilities, as presented below:

Outdated content

Interviews with graduates revealed that while the curriculum provided basic skills in civil engineering, it did not cover several essential skills currently demanded in the labour market. For example, graduates highlighted the continued use of traditional building materials and techniques, such as wall putty (white skim), glass stone 3D texture wall stickers, and commix, instead of more modern alternatives like colour paint, wood carpet for flooring, and gypsum decoration for roofing. A participant who graduated from Civil Engineering emphasised the lack of training on these modern materials and techniques, as noted below:

> During the classroom session, we were taught the procedures for wall painting using traditional colour paint. But in the industries, we have met with new technology in wall finishing. Modern materials are used in wall finishing, which are cheap, durable, and less time-consuming. For instance, instead of using colour for wall painting, which is sometimes expensive, the wall must be skimmed before painting. This leads to doing double tasks, which is time-consuming and cost-ineffective. There are materials called commix that, when used, do not need to be skimmed, and they last for a long time compared to colour paints (interview, Civil Engineering Graduate 01).

The findings also show that there are stages of building construction that are not taught well during training. They say what they are taught is the only painting that starts with the first coat, 2nd up to the 3rd coat. However, in the field, painting involves various stages. In this, one of the CEG shared the following experience:

> By practising painting with our institution's structures, we only learned colour painting from our previous technical colleges. It was common for us to sand the wall and then paint it three times. However,

> before colour painting, a number of activities are carried out in a working environment. To remove corrugations, scrape the surface, smear the undercoat or binder, and then paint the desired shade. During our initial meeting, we were introduced to all these technologies (interview, Civil Engineering Graduate 06).

The quote above illustrates how technical education curricula continue to rely on antiquated, costly, and time-consuming content while innovative, low-cost, long-lasting, and time-efficient technology is used in actual workplaces. It appears from this that students are taught materials that are out of date and ones that do not apply to the job market. This shows that although the technical education curriculum for civil, electrical, and biomedical engineering imparts some fundamental engineering skills to graduates, it is not relevant to what is actually needed in the workplace because some parts of the curriculum are based on outdated content. They are extremely superficial when compared to the skills required in the actual workplaces.

These findings on the outdated content taught corroborate the study by Thindwa (2016), who found that barriers such as an obsolete curriculum led to TET graduates in Malawi, whom employers did not prefer. This was contributed by an outdated curriculum, which was not aligned with the industry requirements, and this, in turn, affected the quality of the graduates. The findings are also in tandem with the findings by Dasmani (2011) in Ghana, which shows that the outdated and irrelevant curriculum is attributed to unemployment among technical graduates. One possible implication of this finding is that, although the technical education curriculum in civil, electrical, and biomedical engineering introduced basic skills to graduates, it is not fully relevant to the current job market. Some parts of the curriculum contain outdated content and are insufficiently comprehensive compared to the skills needed in the labour market.

The use of the lecture method in teaching and learning

The study found that teaching and learning methods were predominantly theoretical, with lectures significantly outnumbering workshop sessions. For instance, fifteen civil engineering graduates reported that four days a week were dedicated to lectures, while only one day was allocated for workshop activities. They also noted that even the single day allocated for practical sessions was divided among different modules, resulting in limited hands-on experience. This imbalance between theoretical instruction and practical application highlights a critical gap in the current curriculum, which may hinder the development of industry-relevant skills among graduates. Specifically, one graduate revealed:

> We are always divided into two groups, and each group attends practicals for four (4) hours only per week due to the enormous number of students

> in the classroom compared to the available workshop facilities. Thus, there are instances when we conclude the session without completing the assigned task (interview, Civil Engineering Graduate 04).

Additionally, graduates insisted that the practical skills taught in technical education institutions do not prepare them to match the needs of the real working environment. In this, one of the graduates from Civil engineering admitted:

> We struggle to execute engineering work in the field because we are strong in theory but weak in practical applications. Most of the practical works are taught through lecturing and demonstration. For example, we can be taught simply the fundamentals of surveying. Still, there are many applications of survey skills in the real world that we are unable to accomplish (interview, Civil Engineering Graduate 07).

Furthermore, about 80% of the interviewed graduates in civil engineering acknowledged that they were poor in plumbing work since they were taught only theory and demonstration of some plumbing equipment. One of the graduates in civil engineering insisted:

> I had never tried any plumbing work during my schooling, even in my industrial practical training session. I met with this work during this first appointment, and it became a challenging task for me since I couldn't even perform simple plumbing work (interview, Civil Engineering Graduate 12).

It is interesting to note that even electrical and biomedical engineering graduates supported the idea that many practical sessions are taught through lecturing and demonstration using images and diagrams of biomedical equipment. Graduates noted that Magnetic Resonance Imaging [MRI] pictures and diagrams were used to demonstrate the various components of the machine and how to use and maintain it. For instance, one graduate commented: *"Neither in our technical institution nor during industrial practical training performed any MRI installation, maintenance, or machine repairs practically. How are we going to install, maintain, or fix it at the real working place?"*

The quotes indicate that technical institutions still rely primarily on lecturing methods with limited hands-on activities, resulting in graduates who do not meet industry demands. This finding corroborates a study by ATE, which shows that although the CBET system has been proposed and is in various stages of implementation, it has produced mixed results. Many courses continue to use an outdated knowledge-based system rather than focusing on skills acquisition (ATE, 2011). Similarly, Paulos (2023) reported that civil engineering programmes are not aligned with industry needs, as inadequate time is allocated to practical training in workshops, resulting in an overemphasis on theoretical sessions. This produces graduates with skills mismatched to the requirements of the real working environment. Furthermore, Anindo (2016) found that the predominant teaching method in Kenya's technical institutions is lecture -based and teacher-centred, which neither equips youth with employable skills nor empowers them to be self-reliant. These findings align with a Nigerian study by Orimonu and Okoye (2016), which found that technical education curricula for subjects with practical content are typically organised with 67% theoretical classes and 33% workshops, following conventional lecture-based methods of knowledge transfer.

One potential implication of the present study's findings is that teacher-centred lecturing remains prevalent in classrooms, resulting in graduates lacking adequate practical skills. To address this, technical education curricula should prioritise practical hours over theoretical lecturing to afford students more opportunities for hands-on activities. This recommendation is underscored by the NACTE (2015) study, which advocates for the CBET curriculum by emphasising that while theory serves as foundational knowledge, increasing practical hours is essential.

Outdated workshop facilities used in teaching and learning

The study revealed that many teaching and learning facilities in technical education institutions, particularly workshop equipment and machines, were outdated. Fourteen out of twenty civil engineering graduates reported difficulties in using modern engineering equipment. They emphasised encountering new engineering tools in their workplaces that they had not been trained to use during their education. For instance, graduates highlighted that modern surveying equipment was unfamiliar to them, indicating a significant gap between their training and the technological demands of the industry. One graduate specifically noted this disparity, illustrating the challenges faced when transitioning from education to employment, as highlighted below:

> Despite advancements in technology, technical institutes continue to use old prismatic compass surveying devices, while nowadays, a computerised prismatic compass with a prism can measure readings precisely. The primary advantage of this compass is that it eliminates the need for location adjustments and permits simultaneous sighting and reading (interview, Civil Engineering Graduate 11).

It should be noted that since surveying developed in ancient times, the science, methods, and instruments of surveying have been greatly influenced by technological development. Because of the importance of surveying to modern man, the training of engineers (planners, architects) is not complete without instructions on various aspects of surveying. Additionally, biomedical engineering graduates claimed that the teaching and learning equipment used was still of the old version and the modern ones were not available. Thus, practicals were largely conducted through demonstrations using diagrams. One of the electrical and biomedical engineering graduates said:

> Instructors use the MRI diagram to demonstrate the major parts of this machine, how it works, and how to maintain and repair if damage occurs. Again, this student is expected to perform all these activities in a real working environment with a real MRI machine (interview, Electrical and Biomedical Engineering Graduate 04).

From the quotes above, one can ask a question: if this student was taught through a diagram, how can they operate, maintain and repair a complicated or sophisticated machine which they didn't see during practicum? This suggests that technical education institutions are lagging in terms of technology. Some of the workshop facilities used were of old versions, and sometimes instructors in the institutions taught practicals through demonstrations using diagrams of biomedical equipment. This implies that the country's technical education curriculum is behind the technology. This means that students are not taught to adapt to the changing technology; hence, they cannot match the advanced technology in the labour market.

These findings align with those of NACTE (2020), which reported that Tanzania's technical colleges continue to face significant challenges in teaching construction sector programmes because of inadequate equipment and resources that don't match the current industrial technology despite the government initiatives in the education sector. Hence, there existed a skill gap between graduates' skills and industrial skills demands. The findings also concur with the study by Anindo (2016), who found that most of the training equipment in technical training institutions was inferior to industry -standard equipment, and they could not keep up with the current technological advancements. Thus, the violation of the standard for training equipment has affected the value of the expected skills taught at Technical Training Institutions (TTI) when compared with the demands of the current labour market. The current study further shows that technical institutions in most African countries, including Tanzania, are still lagging behind technology as the equipment and machines used to train students are of the old version, and most of those needed are not available in the training institutions; hence, they produce graduates who cannot match the current industrial skills demands.

When students were asked to give their preference on how to improve the quality of skills provided in technical education institutions to fulfil industrial demands, they said that students should have field attachments maybe once in two weeks so that they get to know what is on the ground in the field. Anindo (2016) found similar evidence by reporting that, to improve teachers' and students' professional and academic growth, technology should be included in the technical education and training [TET] curricula and that regular industrial attachment should be provided. Furthermore, graduates suggested having dedicated plans or partnerships between technical institutions and industries for students' industrial practical training (IPT) duration and activities. 68% of the graduates proposed 16 weeks (4 months) of IPT. Hilary et al. (2019) provide evidence for this by arguing that fieldwork in some institutions takes place for a short period, students are not adequately exposed to practical skills, or they are not given enough time to acquire the key competencies needed to become competent in the sector. With respect to the recommendations made by graduates above, it can be inferred that various forms of industrial cooperation are essential to improving technical institutions' ability to provide training that is responsive to the demands of the labour market.

The alignment of the stated Learning Outcomes of the CEBE curriculum with the NACTVET's CBET standards

Learning outcomes are specific intentions of a programme describing what a learner should know/understand or be able to do (NACTVET, 2023). In this regard, three areas of the curriculum were analysed, and findings are presented in the order of principle learning outcomes, enabling and sub-enabling outcomes, and assessment methods proposed as per NACTVET's CBET standards.

Principle Learning Outcomes (PLO)

In exploring information for this term, researchers started with Principle Learning Outcomes (PLO) to determine if they were stated in line with NACTVET standards of curriculum development. The reviewed curriculum consisted of 6 PLO, 120 credits and 18 modules. NACTE recommends 4-6 PLOs for each statement of purpose to qualify. The curriculum reviewed was under NACTVET's requirements in terms of the number of PLOs. However, the review findings show that, even though some of the stated PLOs were work-oriented, some PLOs did not follow NACTVET's CBET standards. This was observed in PLO-1, PLO-3 and PLO-6. For instance, the PLO-3 reads: "Apply principles of maintenance and repair related to Building and Civil Engineering structures (ATC, 2018)". This PLO -3 does not exactly state the specific activities the graduates were supposed to be able to carry. The statement has a verb or *noun* but lacks a *modified phrase*. The PLO could read as: "Apply principles of maintenance and repair items related to Building and Civil Engineering structures to maintain and repair buildings".

Also, PLO -6 reads: "Apply interpersonal communication skills related to the production of reports". This PLO does not state the exact specific occupational activities the graduates are supposed to be able to carry. The statement also has a *verb* and *noun* but lacks a *modified phrase*. The PLO could read as follows: "Apply interpersonal communication skills related to the production of reports to prepare engineering project report." The review findings suggest that about 50% of the stated PLO did not follow NACTVET's CBET standards of curriculum development.

Enabling and sub-enabling outcomes

The review indicated that some of the enabling outcomes did not conform to the NACTVET's standards of curriculum development, and good examples are the enabling outcomes: 3.1, 3.3, and 5.3. For instance, the enabling outcome 3.1 reads: "Select suitable types of building and civil engineering materials". This statement consists of an Action *Verb* and *Noun* but lacks a *modified phrase*. The outcome could read: "Select suitable types of building and civil engineering materials for carrying out construction works". Generally, in each PLO, 1-2 (33%-67%) out of 3 of the stated enabling outcomes did not follow the NACTVET's Standards of Curriculum Development.

Also, the finding revealed that some of the sub-enabling learning outcomes were not stated according to NACTVET's standards. For instance, the sub-enabling outcome, which states, "Carry out installation and maintenance of services, "did not exactly show the problem that the student was going to solve after completion of their study. The statement could read: "Carryout installation and maintenance of services of biomedical instruments and machines". The findings were based on the stated related tasks compared to sub-enabling learning outcomes. In the CBET system, if the indicated sub-enabling is skill-based, 3/5 of their corresponding associated tasks should be skill-based. However, the review showed that most of the stated tasks were knowledge-based while their corresponding sub-enabling learning outcomes were skills-based. For instance, sub-enabling outcome 1.2.5 reads: "Describe pre-stressed concrete". This is a skill-based sub-enabling. However, it was expected that 3 out of 4 related tasks could be skills-based. On the contrary, 2 out of 4 corresponding tasks were knowledge-based, as stated below:

i. *Explain the difference between ordinary reinforced concrete and pre-stressed concrete.*
ii. *Explain the significance of pre-stressed concrete*
iii. *Describe how pre-stressed concrete is made*
iv. *Describe the use of pre-stressed concrete in the construction of building and civil structures.*

The above findings imply that the stated outcomes are not aligned with NACTVET's CBET standards. Technical education instructors should, therefore, be trained on how to construct outcomes according to NACTVET's standards so that the curriculum communicates market demands. According to Cedefop (2012), one of the distinctive features of learning outcomes approaches is that the curriculum is described in terms of what the learner will be able to do at the end of their course of study rather than in terms of objectives, processes and knowledge. Cedefop added that learning outcomes acquired in learning processes should communicate more effectively with the competencies required in the labour market. By focusing on outcomes, the flow of new entrants to the labour market will be much more geared to meeting its needs.

Assessment methods

The findings further indicated that the stated sub-enabling outcomes and assessment methods were not related. For instance, PLO-1 and sub- enabling 1.8.5 in the electrical and biomedical engineering curriculum required students to be able to describe Magnetic Resonance Imaging (MRI). However, the assessment method prescribed does not show any practical activities related to running, repairing or maintaining this kind of biomedical machine, as presented in Table 1.

Table 1

Part of the NTA Level 6 Electrical and Biomedical Engineering Curriculum Content

Sub-Enabling Outcome	**Related Tasks**	**Assessment Criteria**	**Assessment Method**	**Assessment Instruments**
1.8.5. Describe Magnetic resonance Imaging (MRI)	a) Explain the principle of operation of MRI b) Explain the application of MRI c) Identify different types of MRI	Magnetic resonance Imaging is correctly described	Written test Oral questioning Assignments	Assignments Written exams

Source: *Electrical and Biomedical Engineering NTA Level 6 Curriculum from College XX, (2019, pp. 21-22)*

Table 1 shows how the proposed methods of assessment to be used did not relate to the stated sub-enabling outcome. Assessment methods suggested to be carried out in the classroom included no practical activities that could deal with describing MRI components or even maintenance processes. The findings also show that sub-enabling 5.1.1, 5.1.2, 5.1.3….., and 6.4.3 are mathematically related outcomes that needed calculations. However, in each sub-enabling, oral questions were used as a method of assessment. It was expected that these outcomes would be assessed by *competence tests, group assignments,* and *practical works,* to mention but a few.

The assessment methods proposed are homogeneous in almost the whole curriculum document. For instance, from pages 28 to 43 (ATC, 2018), the assessment methods proposed were *assignment, written tests/exams,* and *competence* in all outcomes. No observation, field visit, group work, project or role play indicated as assessment methods. Similarly, on pages 53 to 69 (ATC, 2018), the methods of assessment indicated are oral questions, written tests and observations. This clearly shows that the curriculum developers, perhaps, were cutting and pasting the assessment methods presented under each sub-enabling outcome and the related tasks.

The findings indicate that certain aspects of the curriculum did not conform to CBET standards, particularly in terms of aligning with NACTVET's specified learning outcomes. This deficiency implies that the curriculum was not competence-based. According to CBET principles, clarity and focus on outcomes are crucial. The parts of the curriculum that did not meet NACTVET's standards failed to adequately prepare graduates to meet the skills demands of the labour market. These findings are in line with a study by Munishi (2016), who reported that, at the technical education institution level, it was noted that 6 out of 10 who visited institutions had not reviewed their curricula for over the past five years; thus, curricula had failed to shape the graduates to face the skills demand posed by the potential employers. The findings are, however, in contrast with those of the Asian Development Bank (2014), which reported that, sometimes, the curricula may meet industry needs. At the same time, it was revealed that the competencies acquired may not match the industry requirements. This suggests that the reviewed curriculum could not prepare graduates who satisfy the needs of potential employers. Technical education institutions, therefore, should develop the curriculum's purpose, qualifying with the learning outcomes and assessment methods following the NACTVET's CBET standards of curriculum development. This concurs with Athumani and Manyaga (2010), who argued that qualifications should be described in terms of competencies derived from the needs of the world of work, and curricula should be based on modules with clear meaning and value to meet the prescribed occupational standards (pp. 36)".

Conclusion and Recommendations

The study assessed the alignment of civil, electrical, and biomedical engineering curricula with current industrial skill requirements. Based on the findings, several conclusions were drawn. Firstly, segments of the technical education curriculum in these fields did not adequately prepare graduates with skills to meet industrial demands. This deficiency stemmed from outdated content delivery, primarily through lectures and insufficient hands-on activities that are integral to CBET principles. Secondly, much of the training equipment used was technologically obsolete compared to industry standards, thereby diminishing the relevance of taught content and practical skill acquisition to meet current industrial needs. Thirdly, the stated Learning Outcomes often failed to conform to NACTVET's CBET standards for curriculum development, which emphasise clear competency-based descriptors (NACTE, 2010; NACTE, 2020). This study suggests that the TE curriculum inadequately prepares graduates to meet contemporary industrial skill demands.

Based on the findings and conclusions, the study recommends the following:

i. *Curriculum review and market analysis*

- The existing technical education curriculum should be reviewed through intensive labour market analysis. NACTVET should ensure that this analysis is conducted effectively and that current industrial skills are incorporated into the curriculum.
- The review process should include an increased number of practical sessions to enable students to engage in hands-on activities.
- A one-year compulsory internship programme should be introduced immediately after graduation to allow graduates to gain practical experience and familiarise themselves with working instruments and emerging technologies in the workplace.
- Study tours should be included every 2 to 4 weeks, as industrial attachment programmes are crucial for learning and acquiring practical skills necessary for employment.

ii. *Training and development*

- NACTVET is encouraged to organise training sessions for all technical education institutions on how to develop curricula that meet NACTVET's CBET standards and ensure work-oriented learning outcomes.

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