International Journal of Engineering and Management Research e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-10, Issue-4 (August 2020)
www.ijemr.net https://doi.org/10.31033/ijemr.10.4.7

Relationship between Technical Skills Acquired and Skills Required on Electrical Equipment Servicing among Electrical Engineering Technicians in Manufacturing Industries in Kenya

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ABSTRACT

The research sought to investigate relationship between technical skills acquired and required on electrical equipment servicing amongelectrical engineering technicians in manufacturing industries in Kenya. Quantitative research techniques were adopted in this study. The study was conducted in Nandi and Uasin-Gishu counties in Kenya, which have 7 TVETA registered and licensed public Technical Training Institutions offering Diploma, Craft Certificate and Artisan electrical engineering courses. The target population was 96 electrical engineering trainers, 15 employees from manufacturing industries and 65 electrical engineering technician trainers. A sample size comprised of 50 electrical engineering trainers, 7 employees from manufacturing industries and 29 electrical engineering technician trainers. Questionnaire were used to collect data. The instrument was pre-tested to ensure its validity by determining the internal consistency of the research instruments. Data were analyzed using descriptive and inferential analysis. There was a positive significant relationship (r=0.408, p= 0.004 2-tailed) between the electrical engineering technician acquired training at TVET institutions and the skills required for electrical equipment servicing at manufacturing industries in Kenya. The Kenyan government through the ministry of education should ensure adequate training is carried out to achieve training relevant for the needs of the industry. KICD in collaboration with CDACC and SSACs should develop a curriculum that addresses the competence requirements and occupational standard needs of the manufacturing industries.

Keywords-- Technical, Acquired Skills, Required Skills, Equipment, Servicing, Manufacturing, Industries

I. INTRODUCTION

Core skills are skills that enable individuals to constantly acquire and apply new knowledge and training. They build upon and strengthen the skills developed through basic education; the technical skills needed for specific occupations or to perform specific tasks or duties; and personal attributes such as honesty, reliability, punctuality and loyalty [1]. The ILO uses the terms ‘core skills’ and ‘transversal skills’ interchangeably when referring to the generic skills sets of workers.

In many countries, TVET technicians’ problem solving/analytical skills and creative/critical thinking skills are said to fall below employers’ job requirements. These skills, referred to as higher order thinking skills, are considered essential for countries’ transition to a knowledge-based economy [2]. The main way of teaching these skills is by adopting learner-centered, applied and/ or experiential pedagogies. Yet over half of all respondents to the lead ministry survey said that their ministry or government has not yet adopted student-centered approaches to prepare TVET learners for their country’s transition to a digital and/or knowledge-based economy. Survey respondents pinpointed problem solving/analytical skills as the most important core skill for employment over the next 10 years, so TVET pedagogies will need to change. Consequently, institutions of learning across the globe have continuously been the education of technology and engineering, so as to establish constant relevance with the skills requirements of the manufacturing industries and at the same time adequately prepare trainees for their future occupations [3]. In Spain, guidelines illustrated by the Education Ministry concerning engineering technician training is that engineering technicians should be able to analyze, design, implement and improve complex systems composed of machinery, technology and energy. This involves drafting, designing and the development or installation of electrical or energy equipment, [4].

In Brazil, Vicente Ferreira de Lucena et al [5] illustrate that the engineering technician curriculum follows constrained requirements that have been drafted by the ministry of education, which makes it difficult for the electrical engineering technician curriculum to be modified. Skills mismatches are a major problem in the Asia-Pacific and a main factor in explaining why young people in the region are between three and six times more likely than adults to be unemployed [6]. Skills gaps are now reported by around half of all employers across the region, including in some fast-growing economies.

In Nigeria, the Federal Republic of Nigeria [7] illustrates that the main objective of engineering technician training among others is to provide the technical knowledge and vocational skills necessary for economic development. Rufai, Abdulkadir & Kagara [8] indicated that in a bid to address the technical skill deficiency among technician trainees, the industrial employers subject the engineering technicians to retraining programs, and in circumstances where the industrial employers cannot employ and retrain, it is convenient for the industries to employ international experts to do the same. It has been found out that the collaboration and linkages between the training institutions and the industries has been poor therefore addressing the mismatch in the skills has not been achieved for quite some time.

The national training structure should therefore be made to involve all the relevant stakeholders in order to have a harmonized curriculum that is used and implemented equally across all TVET institutions, whether public or private in order to efficiently meet the needs of the industry [9]. To achieve this, a proper knowledge about the current industrial trends and the needs of the existing labor market, as well as the existing occupational standards developed by the manufacturing industries must be achieved in order to present these requirements and develop a communication platform between the industries, KAM, TVET institutions and the national qualifications framework so as to facilitate future skills and career development [10].

A comprehensive report on the status of engineering technician training in Kenya (INSEAD, 2018) showed that Kenya is lagging behind the Sub-Saharan vocational and technical skills, retention of skills relevant for performance in the manufacturing industry. It further indicates that only 34% of trainees enroll to TVET institutions with the expectations of getting job opportunities after graduation while only 22% enroll because of the quality of education offered. This is an indicator that there is skepticism about the quality of training offered in TVET institutions and its relevance to the job market. This study therefore sought to examine the electrical engineering technician training relevance for electrical equipment servicing in Kenyan manufacturing industries.

II. LITERATURE REVIEW

2.1 State of Electrical Engineering Training around the World

Da silva [11] however explains that the only way that the institutions of higher learning have tackled this hurdle is through an extensive linkage and collaboration between the training institutions and the industries so that investments on co-operative training programs can be able to fulfill the required relevant skills acquisition by the engineering technician trainees. Canada leads the OECD in proportion of the population that has acquired tertiary education, and this factor contributes to the overall strength in research in the fields of science and technology. In articulating the status of engineering technician education with regards to if there's a shortage of supply of a skilled labor force or if there's an overall surplus [12] indicate that aggregate shortage of skilled labor is an overall difficulty in finding workers that can fill positions across the economic divide, while an existence in mismatch means that the employment opportunities do not match the skills of the trained and unemployed labor force.

In terms of future projections on the skills that will be required by the Canadian industrial labor market, Brynjolfsson and McAfee [13] agree that fundamental skills, practical skills and complementary skills for Science Technology Engineering and Mathematics application will be relevant to the needs of the industry.According to Electrical comms data 2015, the development of commercial automation processes, sensor fit-outs, tailored PLC programming and SCADA systems, industrial process automation services and devices has led to an increase in demand in specialist skills for this new technology requiring revised training strategies in Australia.

The major manipulative skills set required for the new technologies is maintenance and equipment servicing. Lauglo and Mclean [14] indicated that if the collaboration between TVET institutions and the industry fails, the engineering technician training will cease to produce a skilled labor force, while at the same time the industries will have to invest on on-the-job training for all new employees, since the employment sector cannot afford to risk employing an inadequately skilled labor force.

In Nigeria, Onoh [15] indicates that maintenance and servicing skills are prerequisite for the preparation of technician trainees for the world of work. The critical skills postulated are diagnosing basic faults, evaluation of electrical test equipment effectively, understanding the basic regulatory planners for training of requirements in maintenance, use of circuit diagrams as an aid to maintenance among others.

Hoeckel, [16] noted that most industries needed a trained labor force that were able to adapt to technological changes and therefore the engineering technicians must be trained by TVET institutions with the capacity of establishing linkages with the industries. This means that for the training offered by TVET institutions to be successful, continuous collaborations with the industries have to be established.

Majority of the TVET institutions are sponsored by the Kenyan government, while at he same time the government, through sessional Paper No. 6, encouraged theprivate investors to venture into vocational education and training. This however provided a window of

opportunity for private TVET institutions to be established leading to irregular curriculum implementation since the required oversight structures and authorities had not been put in place to check on the infrastructural and resource adequacy relevant for effective training[17]. In view of the ever-changing demands of the industries and an increasing diversity of the needs of the trainees, it has become necessary to redesign the curriculum to meet these needs.

2.2. Concept of Skills Required

Skills required at the manufacturing industry are the competencies the manufacturing industry expects the engineering technician to possess relevant to the tasks at hand. TVET institutions are required to facilitate training that offers engineering technicians with modern and up-to date skills that meet the needs of the manufacturing industry. The lack of constant linkages between the industrial employers and TVET institution trainers in providing input to develop standards relevant to developing a curriculum relevant to the skills requirement of the manufacturing industry, has been the major contributing factor to the existence in disparities between skills acquired by engineering technicians and the skills required by the manufacturing industries[18].

The Kamunge report of 1988 indicated that TVET had been established in the 8:4:4 system of education with the aim of laying the basis for the acquisition technical skills required for the socio-economic development. KICD, (2013) illustrates that in addition to developing the curricula implemented by the TVET institutions, its mandate also includes continuous review, approval of programs and curricula support materials that are in synch with the international TVET standards as well as implementing policies related to tertiary institutions.

The Kenyan parliament through the TVET Act of 2013 established CDACC and gave it the responsibility to design and develop curricula for TVET institutions and also for assessment and certification. This was due to the perceived lack of relevance between the technical skills acquired by graduates from TVET institutions and the technical skills required by the labor market, which meant that the TVET institutions now had the opportunity to realign there training programs to meet the needs of the manufacturing industries.

2.3 Concept of Skills Acquired

Skills acquired at the TVET institutionare the competencies gained by the engineering technician at the end of a training process. Relevance is a key requirement for adoption or use of virtually anything. According to Farrant[19], if the technicians who are the products of the process do not possess the right knowledge, attitudes and skills that are required by the job market, then they are not relevant to the job market.

In Kenya, TVET institutions and the industry is so minimal resulting in a mismatch between the skills acquired at the institutions and the skills needed by the manufacturing industries.A report on the human resources development of2014, indicates that key TVET challenges is that the engineering technician training curriculum and design has little relationship with the needs of the industry.

2.4 TVET Trainers Need to Cooperate with Industry

A study conducted by Obwoge[20] on the status of linking TVET institutions with the industry in Kenya showed that only 8% of the linkages were based on staff exchange, while only 6% of the collaborations were based on trainers' industrial experience. Practical experience in industry allows trainers to have an elaborate view into the modern labor market and to be able to reframe the training process to meet the needs of the manufacturing industries [1].

Trainers, while selecting their training resources, must be able to comprehend the skills and competencies needed at the industries. The understanding of which theoretical content is to be delivered and how to link it with the present technological needs of the industry is paramount, which translates to the trainers comprehending whether the skills being imparted are still relevant or already outdated as espoused by [21].

Obwoge,[20] illustrates that TVET sector tailored to meeting the demands of the country and also be abreast with the global changes in technology.USAID, reported that some of the skills in short supply are engineering technicians skilled to operate some machines and technicians who can repair and service electrical equipment. Collaboration between TVET institutions and the industries is beneficial to the trainees, trainers and prospective employers. It exposes the trainees to real work environment and helps in implementing theory into practice.

In Kenya, the linkages between TVET institutions and the industry is so minimal resulting in a mismatch between the skills acquired at the institutions and the skills needed by the manufacturing industries.A report on the human resources development of2014, indicates that key among the TVET challenges is that the engineering technician training curriculum and design has little relationship with the needs of the industry.

2.5 TVET Curriculum Development in Kenya

The Kenyan government's plan to formulate and develop Competency Based Education and Training (CBET) framework for both basic and tertiary education in order to form the foundation for a new curriculum. This will give the trainees the opportunity to pursue single or various competencies as desired. Nyerere,[22] noted that private TVET institutions have been offering British and American Curricula to address the gaps created by the deficiencies in the KICD designed curriculum. While such externally sourced curricula may be cost effective, KICD notes that it can be of low quality and fail to meet the specific training needs of the Kenyan labor markets.

Karimi et al, [23] indicate that the country has an inadequate number of technicians that is necessary to help in Kenya achieving the middle-income economic status through the manufacturing sector. This means that there is uncertainty in the future of these growth projections despite the major investments in infrastructural projects that cannot be well facilitated since as noted by the vision 2030 blueprint, there is still an existing shortfall the supply of technicians. Awuor, [24] notes that insufficient collaboration between engineering technician training institutions and the manufacturing industries has been the main cause of mismatch between the skills demanded by the industries and the skills acquired from TVET institutions.

TVET institutions have been given the major prerogative of developing and coordinating a system that will generate a skilled labor force for the development of the Kenyan economy. Apart from curriculum implementation, the training disseminated should be able to bring forth skilled artisan, craftsmen and technicians that have acquired the required technical skills through practical training and integrated learning. The learning institutions should also be able to effectively transfer technological needs assessment through appropriate collaboration mechanisms between the TVET institutions and the industry.This has necessitated the majority of the institutionalized organizations which comprises manufacturing industries and training institutions, to recognize the need for and the importance for implementation of drastic but continuous and sustainable changes in engineering technician training. Reducing the skills gap between the skills acquired by the engineering technicians and the skills required by the manufacturing industries should therefore be a priority in order for the training programs to be relevant to the current world of work.

III. THEORETICAL FRAMEWORK

This research was guided by the human capital theory of school effectiveness as espoused by [25]. The theory has four major ideas: expected results, influence, intellectual input and social input, which as a result establishes the eminence of training offered acquired at TVET institutions. According to this theory, the competencies exhibited by an individual is not solely dependent on one's individual capabilities or talent, but is more about how the individual chooses to practice a skill and to act on it. The major objective of education and training is to therefore initiate, expose and guide the trainees towards achieving these competencies, where they can satisfactorily acquire the ability to execute resonant academic and ethical career decisions.

According to Leadbeater [26] the production, relevance and utilization of acquired technical skill and knowledge has always been meant to propel a cost-effective trade and industrial growth and the most extraordinary aspect of this growth is its capacity to generate non-stop development of new services and products, which makes it very essential to redesign the educational and training needs to establish the potential to create and disseminate knowledge and skill throughout any given population or generations. Given that the trainers have little capacity to develop the required relevant skills to the trainees, they have to develop new methods of research as well as creating the appropriate linkages with other researchers and industries [27].

A training institution that constantly seeks to offer better training for relevance must therefore know how to point out and use efficient and ethically justifiable relationships and collaborations in order to facilitate intellectual and skill excellence. However, majority of the institutions of learning do not know how to improve these collaborations. This leads to the lack of capacity to apply the relevant knowledge into practice and increase the capacity to innovate and experiment for better skills to be imparted on the trainees. The human capital is therefore quantified through the skills outcomes of the acquired training of the trainees graduating from the system.

IV. RESEARCH METHODOLOGY

Descriptive designs were used to establish associations between variables in the skills acquired by the electrical engineering technician, skills required by the industries and the existing mismatch between these skills. The data was collected through survey research design by using questionnaires which allowed the researcher to gather information, analyze, present and interpret, [28]. Quantitative research techniques were adopted in this study. Quantitative research designs are either descriptive or experimental.

The study was conducted in Nandi and Uasin-Gishu counties in Kenya, which have 7 TVETA registered and licensed public Technical Training Institutions offering Diploma, Craft Certificate and Artisan electrical engineering courses. From the government sponsored TVET institutions in Nandi and Uasin-Gishu counties, an expected 65 electrical engineering trainers were targeted. From the selected industries within the two counties, 96 electrical engineering technicians and their employers were targeted.

According to Schomburg[29], a 30% sample size of the target population is representative enough in conducting a survey. The 96 electrical engineering technicians targeted were estimated to be employed in the 15 manufacturing industries located in Uasin-Gishu and

Nandi counties. However only 7 manufacturing industries could allow the researcher to conduct the survey therefore a total of 50 electrical engineering technicians (52.08% of the target population) responded to the technician's questionnaire. Of the 65 electrical engineering technician trainers teaching in the public technical training institutes within Uasin-Gishu and Nandi counties, only 29(44.6% of the target population) responded to the trainer's questionnaires.

The questionnaires that were designed to collect data with respect to the objectives of the study were developed for the electrical engineering technicians, the electrical engineering trainers and the employers at the manufacturing industries. From the questionnaires it was possible to measure the major variables illustrated in the conceptual framework.

Validity was tested by subjecting the research instruments to thorough scrutiny by the supervisors and lecturers in the department of Technology Education. In order to evaluate the content validity of the instruments, the researcher came up with elements that constituted adequate coverage of the conceptual framework as guided by the research objectives.The suggestions were therefore used to make necessary changes. The researcher undertook a pilot study in Bomet County, which has similar characteristics with one of the study areas. For a research instrument to be reliable, most professionals recommend a Cronbach's alpha of 0.7 and above, with 0.6 being the lowest acceptable value.

After data collection, the researcher coded and entered the data into the computer for analysis using the SPSS version 20.0. Descriptive statistical techniques such as Frequencies, percentages, means and standard deviation, inferential techniques using the Pearson Product Moment correlations.

V. RESULTS

5.1 Overall Rating of the Training Acquired by the Electrical Engineering Technicians

Based on the research findings illustrated by the parameters described to form the training process, the electrical engineering technicians rated the training acquired as fair with a mean of 3.41 and a standard deviation of 0.531 as illustrated by the table 1. The competence of the trainers to deliver subject content, relevance of skills acquired in TVET institutions and the adequacy of training equipment was rated as good, with an average mean of 3.88, 3.73 and 3.55 with standard deviations of 0.498, 0.504 and 0.747 respectively. However, collaboration between TVET institutions and the manufacturing industries, ICT application by trainers in training and adequacy of modern automation and control equipment for training was rated as fair, with a rating of 3.26 and 2.65 with standard deviations of 0.780 and 0.870 respectively.

Table 1: Rating of the training acquired

Variable	Mean	Std. Dev
Average rating on capacity of delivery by trainers	3.88	0.498
Average rating on relevance of skills acquired	3.73	0.504
Average rating on availability of training resources	3.55	0.747
Linkage and collaboration with the industries	3.26	0.780
Application of ICT and availability of modern automation and control training equipment	2.65	0.870
Average rating on the training acquired	3.41	0.531

For the acquired training to be relevant to the needs of the manufacturing industries, trainees have to be equipped with relevant and adequate technical skills. Lauglo and Mclean [14] indicate that one of the direct impacts of poor industry-technical education collaboration is that technical education will fail to generate qualified skilled workers.

This shows that the training acquired by electrical engineering technicians at TVET institutions is not as satisfactory as it should be in order to meet the requirements to service electrical equipment at the manufacturing industries, therefore the TVET institutions need to ensure the relevant training equipment especially on modern automation and control training infrastructure is adequate, and collaboration between TVET institutions and the manufacturing industries should be enhanced.

5.2 Perception Scale and Weighting for Skills Acquired versus Skills Required

Two sets of similar parameters representing the technical skills acquired from electrical engineering technician training and the technical skills required for electrical equipment servicing were identified. The electrical engineering technicians rated the skills acquired at the TVET institutions and the technical skills required at the manufacturing industries. The perception scale and weighting of the skills acquired and the skills required are as illustrated by table 1 below. The electrical engineering technicians therefore rated the technical skills acquired at TVET institutions and the technical skills required by the manufacturing industries relevant to electrical equipment servicing as illustrated by table 2 below.

Table 2: Perception scale and weighting for skills acquired versus skills required

Scale	Skills acquired	Skills required
1.00 - 1.49	Very poor	Strongly

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-10, Issue-4 (August 2020)
https://doi.org/10.31033/ijemr.10.4.7

		Disagree
1.50 - 2.49	Poor	Disagree
2.50 – 3.49	Fair	Undecided
3.50 – 4.49	Good	Agree
4.50 – 5.00	Very Good	Strongly Agree

5.3 Rating Skills Acquired versus Skills Required

From the findings of table 3, the technical skills acquired by electrical engineering technicians were all lowly rated, with the skills required to operate computer numeric controlled machine rated as poor with a mean of 2.27 and a standard deviation of 1.016, whereas the electrical engineering technicians agree that the same skill is required at the industry, with a mean of 3.90 and a standard deviation of 1.065.

Skills acquired for computer simulation, programming techniques and knowledge on design and interpretation of engineering blueprints were all lowly rated fair, with means of 2.47, 2.59 and 2.76, with standard deviations of 1.195, 1.039 and 1.080 respectively. Consequently, the electrical engineering technicians agree that these skills are required at the industry, with means of 3.83, 3.82 and 3.86, with standard deviations of 1.059, 0.962 and 1.030 respectively.

However, the skills required to diagnose and repair faults in case of machine failure was highly rated as fair, with a mean of 3.44 and a standard deviation of 1.033, with the technicians also agreeing that the same skill is required at the industry with a mean of 4.28 and a standard deviation of 0.834. This indicates that the only technical skill acquired at the TVET institutions that was closely related to the skills required at the manufacturing industry is the skill to diagnose and repair faulty machines.

Table 3: Rating skills acquired versus skills required

	Skills Acquired at TVET institutions		Skills Required at Manufacturing Industries	
Variable	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**
Skills to do computer simulation	2.47	1.195	3.83	1.059
Skills to operate Computer Numeric Controlled Machines	2.27	1.016	3.90	1.065
Programming Techniques and repair of electronic equipment	2.59	1.039	3.82	0.962
Knowledge on design and interpretation of engineering plans and blueprints	2.76	1.080	3.86	1.030
Skills to Diagnose and repair faults in case of machine failure	3.44	1.033	4.28	0.834

5.4 Correlation Analysis

Electrical engineering technician training was defined by the technical skills acquired by the electrical engineering technician at the TVET institutions at the time of completion of studies. The Pearson's Product Moment correlation was therefore found sufficient to establish the strength of the relationship between the technical skills acquired at the TVET institutions, and the technical skills required by the manufacturing industries for electrical equipment serving. The findings are presented in the table 3. From table 4 above, the analysis of correlation of the technical skills acquired at the TVET institutions and the technical skills required by the manufacturing industry, the technical skills acquired had a Pearson correlation (r=0.408, p= 0.004 2-tailed) when correlated with the technical skills required at the manufacturing industry.

Table 4: Correlations of technical skills acquired and technical skills required

		Skills acquired	**Skills required**
Skills acquired	Pearson Correlation	1	.408**
	Sig. (2-tailed)		.004
Skills required	Pearson Correlation	.408**	1
	Sig. (2-tailed)	.004	

**. Correlation is significant at the 0.01 level (2-tailed).

The result is an indication that there is a significant positive relationship between the technical skills acquired by the electrical engineering technicians at TVET institutions and the technical skills required by the manufacturing industries for electrical equipment servicing.While much attention has been given to the emerging industrial innovations and trends in electrical engineering technology for TVET institutions, one of the most critical issues has remained to be the curriculum content that should facilitate relevant training that equips the electrical engineering technicians with the modern cutting edge technical skills which include developing

electrical schematics, data collection and analysis, operation of computer systems, electrical and electronic equipment maintenance and upkeep among others [15]. This shows that for the electrical engineering technician training to be relevant for the manufacturing industry, the curriculum and training equipment at TVET institutions should be up-to date with the technical skills requirements of the manufacturing industry.

VI. CONCLUSION

The findings indicate that skills necessary for diagnosing and repairing of faults in case of a machine failure was relevant and consistent with the needs of the industry. There is a significant positive relationship between the technical skills acquired by the electrical engineering technicians at TVET institutions and the technical skills required by the manufacturing industries for electrical equipment servicing. The manufacturing industry employers consider both engineering and manipulative skills as well as skills necessary to operate modern automation and control equipment as important. There is a positive significant relationship between the electrical engineering technician acquired training at TVET institutions and the skills required for electrical equipment servicing at manufacturing industries in Kenya.

RECOMMENDATIONS

The Kenyan government through the ministry of education should ensure adequate training is carried out to achieve training relevant for the needs of the industry. KICD in collaboration with CDACC and SSACs should develop a curriculum that addresses the competence requirements and occupational standard needs of the manufacturing industries.

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