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CHALLENGES AROUND EMPLOYABILITY OF ENGINEERING GRADUATES IN AFRICA: CAN INDUSTRIAL SECONDMENTS BE A REMEDY?

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BACKGROUND: WHY ENGINEERING?

Improving the status of engineering practices, in a country or region, is positively related to sustained economic development as defined by the Sustainable Development Goals (SDGs) 8 (Decent Work & Economic Growth) and 9 (Industry, Innovation & Infrastructure), particularly for its contribution to strengthening the capacity of the industrial sector which is critically needed to sustain economic growth. Given their broad reach and involvement in modern societies, engineering fields can be linked to almost all the SDGs, either directly or indirectly. Moreover, we find that there are visible correlations between GDP per capita and the number of engineering practitioners (EPs) per 100,000 persons in countries countries that have a larger number of EPs also happen to be those with higher GDP/capita (see Table 1). A global study, in 2016, found evidence to support a strong, positive link between engineering strength in a country and both GDP/capita and investment/capita (Cebr and Royal Academy of Engineering 2016). The same study quotes Prof. Calestous Juma, of the Harvard Kennedy School, mentioning that "you cannot have an economy without engineering…." (p. 10).

Table 1: Correlation between countries' GDP/capita and EPs per 100,000 persons

Country	**Approx. GDP/capita US$**	**Approx. EPs/100,000 popn %**
Seychelles	14,000	14,000
Mauritius	11,000	400
Botswana	7,500	275
South Africa	6,000	200
Eswatini	3,500	140
Zambia	1,700	75
Tanzania	1,000	70
Mozambique	500	35

Source: (SADC 2019; Mohamedbhai 2021)

Engineering strength in countries was measured according to an index named 'engineering index' (Ei), which is defined as 'a measure of country's ability to conduct key engineering activities in a safe and innovative way.' Components of Ei concern the size and quality of: digital infrastructure, engineering industry, infrastructure, knowledge, labour force, and safety standards. (source: Royal Academy of Engineering 2020).

SHORTAGE OF ENGINEERING PRACTITIONERS AND EMPLOYABILITY CHALLENGES: A DISSONANCE

Relative shortage of engineering practitioners in Sub-Saharan Africa has been reported as a major concern in many studies on industrial and technological development of the region. In 2013, the UNESCO Director General mentioned that in Namibia, Zimbabwe and Tanzania, there is one qualified engineer for a population of 6,000 people compared to one engineer per 200 people in China [and 1/311 in UK; 1/227 in Brazil].

Table 2: Number of Registered Engineers in East Africa

Country	No. of Registered Engineers	Population	No. of registered Engineers Population Per Registered Engineer
Uganda	1,406	43,000,000	30,714
Kenya	2,586	55,405,672	21,425
Tanzania	7,610	62,080,012	8,158
Rwanda	850	13,394,215	15,758
Burundi	15	12,378,962	825,264
South Sudan	?	11,375,047	?

Source: (Alinaitwe 2021)

However, there is a particular dissonance in reporting the status of engineering in East Africa and Africa at large. If there is a significant shortage of engineers from what is required, then it follows that the recent engineering graduates should quickly find appropriate employment; but that is not the case. A large number of African countries report a significant number of local engineering graduates finding it difficult to find jobs within their fields (Royal Academy of Engineering 2012; Mohamedbhai 2014; Confederation of Tanzania Industries 2018).

PROBLEMS OF COMPETENCE

The above dissonance seems to emerge, partly, from the competence of engineering graduates, which has been called into question by some studies. A survey in 2014 by the Inter-University Council for East Africa (IUCEA), which regulates higher education in the East African Community's countries, reported that, in Uganda at least 63% of graduates were found to lack job market skills; while in Tanzania, 61% of graduates were found to be ill prepared. In Burundi and Rwanda, 55% and 52% of graduates, respectively, were perceived to be incompetent, and in Kenya 51% graduates were believed to be unfit for jobs (Nganga 2014). In Tanzania, the Science, Technology and Innovation Policy Research Organization (STIPRO) conducted a study in 2011 on local technological capabilities and foreign direct investment.

The findings of the study relayed that in manufacturing, agriculture and mining, firms that were based on foreign investment capital had weak linkages with local skills and capabilities (including labour and other firms) and that was partly due to expressed concerns about the limited technological capabilities of local labour and firms (STIPRO 2018). In the same line, a study that was carried out by the Royal Academy of Engineering (2012) concluded that engineering academic staff in sub-Saharan Africa, although qualified "had very little exposure to engineering practice [in industries and public works]". It also pointed out the teaching style adopted in most academic institutions in the region could be described as "chalk and talk" as opposed to problem-based-learning (PBL) and more practical/engaging styles of teaching and learning. A number of these same studies report that, in most African countries, there is heavy reliance on engineering practitioners brought from outside Africa to work on engineering projects and in industries, making opportunities of employment limited for local practitioners. In general, the picture that emerges is that there is a shortage of competent engineering practitioners to meet the needs of local engineering activities (including local industries, public sector, training, consulting, etc.). The challenges are both quantitative and qualitative.

INSTITUTIONAL PROBLEMS

Another part of dissonance emerges from a combination of poor institutional infrastructure, limited use of new teaching and training techniques and equipment at engineering schools, weak industry-academia linkages, weakness in communication between stakeholders in the engineering ecosystems, and challenges with accreditation and registration of engineers and technologists. Given such challenges, there is no question that engineering education in East Africa, and the continent overall, needs review and readjustment or restructuring (SADC 2019; Sheikheldin and Nyichomba 2019; Kraemer Mbula, Sheikheldin and Karimanzira 2021).

THE ROLE OF STUDENT INDUSTRIAL SECONDMENTS

Being an important bridge between theory and practice, engineering education has been observed to yield more favourable results when practical training is integrated, in various ways. One noticeable approach is co-curricular activities that include applying what is learned in class and learning by working to solve real-world problems. These co-curricular activities include industrial training/attachments of students while at school, internships with industries right after graduation (or during times off school), voluntary activities related to the field of study (such as community service or development projects), and joining clubs or organizations that include activities that engage students with the larger environment and society (Burt et al. 2011).

One practice that has a positive contribution in preparing engineering students for employment after graduation is student industrial secondment (SIS) programs. SISs are temporary placements of college and university students in relevant industries where they receive direct on-the-job training, with actual work responsibilities.

Besides getting to put what they learned in classes and labs into practice, thus honing their theoretical attainment with practical experience, SIS placements allow students to gain tacit knowledge and an appreciation for additional important employability skills that are not often taught in academia (e.g., teamwork and professional communication, performing under real-world pressures, dealing with operational and logistical constraints, and meeting industrial standards). In both developed and developing countries, correlations have been found between engineering SIS programs and increased employability of STEM graduates (Friel 1995; Hackett, Martin, and Rosselli 1998). However, to be effective, quality of such programs matter.

STIPRO PILOT PROJECT

It was in the light of the above that STIPRO, with the support from IDRC, initiated a project to explore best practices in running robust engineering SIS programs coordinated between universities and industries. The project was carried out in three main phases: (I) surveying of SIS best practices in East Africa and other developing countries, (II) action research by piloting long-term SIS placements, (III) synthesizing the findings and widely disseminating the results to stakeholders. To address some of the weaknesses of the conventional internship programs at universities, a pilot project was initiated – the students industrial secondments. The project supported a small number of third-year engineering studentsfrom the College of Engineering and Technology, University of Dar es Salaam, and the College of Science and Technology, University of Rwanda. The project was focused at improving the existing internship programs in two major ways: it took a year as against two months in the existing programs, and it made sure the students received stipends close to normal salary along with the responsibilities of a normal job.

The result of the pilot project was positive: Across the board, students, industrial supervisors and academic supervisors reported a positive return from the SIS placements. The highlights from the student reports show similarities in two aspects: Increase in employable skills: All students' reports highlight an increase in hands-on skills and understanding of practical/work environments; and Increase in confidence: comparing the level of confidence in their own skills, from the point when they began the SIS placement to the point they finalized their placement, the reports show that the students had gained significant confidence in their ability to secure employment after graduation.

The approach that was used by this project was based on the hypothesis – or lens of inquiry – that strengthening the linkage between engineering study, practice and employability is a 'leverage point' in the engineering ecosystem of a country or region. Leverage points are places of intervention in a complex system where change has a significant ripple effect throughout the entire system, influencing many components that were not touched directly (Meadows 2010).Engineering ecosystems are broad and interlinked, and so intervening in them has to be selective to maximize desired change (Mutambala et al. 2020).

CONCLUSIONS AND POLICY RECOMMENDATIONS

With the shortage of local, competent engineering practitioners being a challenge to sustainable development, existing engineering ecosystems need to transform and address the challenge. The SIS project has shown potential in improving the professional competence (and thus employability) of engineering students through methods such as student industrial secondment (SIS) programmes and problem based learning, among others. However, for such methods to work properly, more efforts and effective coordination among stakeholders in the engineering ecosystem are required. There is therefore a need to:

- Improve communication, collaboration and planning between government, academia and industries to address demand and supply of engineering practitioners (EPs).

- Higher learning institutions should seek to enhance and invest in co-curricular activities, including long-term student industrial secondment (SIS) programs.

- Problem Based Learning (PBL) and Challenge Based Learning (CBL) in engineering curricula should be treated as essential, not only an option.

- In the same vein as promoting PBL, change from 'knowledge-based curriculum' to 'outcome-based curriculum' is also recommended to reduce the mismatch between training of engineering practitioners and requirements of industries.

- Bring engineering to the forefront of the debates and policymaking for the STI Strategy for Africa (STISA) 2024 and for the SDGs. They need to be at the forefront because they influence almost every aspect of both STISA and the SDGs.

- Improve collaboration and communication between East African (and African) engineering boards so as to broaden the work/employability prospects of engineering practitioners and encourage improved and dynamic accreditation of EPs.

- African governments should legislate to ensure that transnational corporations and engineering companies from foreign countries provide professional training to local engineering students and employ local engineering graduates wherever possible to enable technology transfer.

- Incentives should be explored to make more engineering practitioners, especially fresh engineering graduates, willing to work in rural areas in Africa, where the biggest challenges to SDGs are.

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