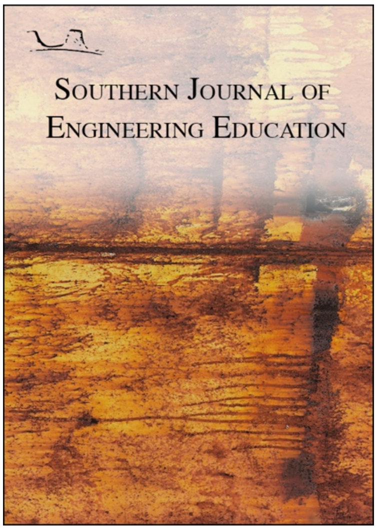

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Leverage points in engineering ecosystems: student industrial secondments in East Africa

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While the relative shortage of engineering practitioners in Africa has been reported as a major obstacle on the road to development, a significant number of existing engineering graduates still find it difficult to find employment in engineering fields. This dichotomy may be partially explained by the inability of local industries to absorb more skilled labour; a relative deficit (real or perceived) in the competency of local graduates in the ever-advancing areas of science, technology, engineering and mathematics (STEM); and/or a scarcity of opportunities to hone and demonstrate their competency to employers. To address the challenge of competency deficit, this study postulated that promoting effective engineering student industrial secondment (SIS) activities can be a leverage point in the engineering ecosystem by strengthening the linkages between engineering education, practice and employability. The study surveyed the history of engineering practical training in Tanzania, Kenya, Uganda and Rwanda, complemented with a pilot study of four long-term, employment-like SIS placements in Tanzania and Rwanda. The main objective was to observe closely, trial potential models, and learn from and synthesise effective SIS experiences. The study found similarities across the countries regarding experiences with student practical training models, their challenges, and the perspectives of stakeholders. Findings also support that longer durations of SIS placements than currently practised help increase the employability of engineering students. However, in view of the small number of placements, further evidence is called for.

Keywords: student industrial secondments, engineering ecosystem, East Africa, graduate employability

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Introduction

Improving the status of engineering endeavours in Africa in research, training, employment, standards, etc., 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. The same endeavour would also contribute to achieving SDG 4 (Quality Education), which is aimed at ensuring that all learners acquire the knowledge and skills needed to promote sustainable development. Looking at engineering from the angle of economic growth, we find 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 a strong, positive link between engineering strength in a country (measured according to the engineering index (Ei) index, comprising the size and quality of digital infrastructure, engineering industry, infrastructure, knowledge, labour force, and safety standards) and both GDP/capita and investment/capita (Cebr & Royal Academy of Engineering, 2016). The study quotes Prof Calestous Juma: '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 pop**
Seychelles	14,000	500
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

While there is a relative shortage of engineers in Africa in general (SADC, 2019; UNESCO, 2010), there are also many graduate engineers who do not find employment in their fields. It is also common that foreign/international agencies involved in engineering-related activities in the region resort to hiring expatriate engineers rather than employing local engineers, citing as reasons lack of competency and knowledge of industry standards among local engineers, particularly among early-career ones. A study on local technological capabilities and foreign direct investment in Tanzania indicated that weak linkages between local firms and multinational enterprises operating as foreign direct investment firms arise partly from concerns among the latter about the limited capacities of local firms to engage in activities that transfer technological capabilities (Diyamett et al., 2012). A logical question arises from these two realities: if significant numbers of the existing graduates have difficulties finding engineering-related employment, how can it be concluded that African economies require more engineering graduates for their development? What is responsible for this dissonance?

Knowledge deficits – quantitative and qualitative – in science, technology, engineering and mathematics (STEM) in Africa have been observed (Beaudry et al., 2018; Mohamedbhai, 2015a). One practice that has a positive contribution in preparing engineering students for employment is student industrial secondment (SIS) programmes. SISs (under various names) are temporary placements of post-secondary students in relevant industries where they receive direct on the job training with actual work responsibilities. Besides having the opportunity to apply what they have learned in classes and laboratories, thus honing their theoretical attainment with practical experience, SISs allow students to gain tacit knowledge and an appreciation of additional important employability skills not often taught in academia (e.g., teamwork, professional communication, performing under real world pressures, dealing with operational and logistical constraints, and meeting industrial standards). Globally, some correlations have been found between engineering SIS programmes and increased employability of STEM graduates (Friel, 1995; Hackett et al., 1998).

In light of the above, a study was initiated to explore best practices in running robust engineering SIS programmes coordinated between universities and industries. In this paper, a literature review of engineering education in East Africa and experiences of SIS in Africa and other parts of the world is presented. The paper then outlines the design of the study and its implementation, followed by the findings from the study, then discussion, and conclusions.

Engineering education and practical training in East Africa

Engineering education in East Africa at tertiary level was introduced later than other disciplines such as social sciences, especially after political independence from colonisation. The formation of the East African Community (EAC) in 1967 helped unify the education systems across the EAC countries (Despres-Bedward et al., 2015; Kumar et al., 2004). At the time, engineering students from Tanzania and Uganda used to study at the University of Nairobi, Kenya, which was the sole engineering school in the EAC (Kumar et al., 2004). Since then, the number of engineering schools and engineering graduates has increased, but not in concert with the increasing need for qualified engineering practitioners (Nganga, 2014). In the 1980s, the Structural Adjustment Programmes promoted by the World Bank and the International Monetary Fund (IMF) affected higher education in African countries (Case et al., 2015) in ways that led to countries mitigating the effects by increasing classroom size, introducing cost-sharing with student families, and cutting budgets on items such as maintenance of laboratories and curricula updates.

The required number of engineering practitioners in any developing society is an educated guess that takes into consideration the average number of engineers for any population size of a modern, developed society, and the conventional ratio of engineers-to-technologists/technicians, as well as differences between engineers and incorporated engineers (or engineering technologists) on average (Mohamedbhai, 2017; UNESCO, 2021). In 2013, the UNESCO Director-General mentioned in a speech 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'. The ratio is also said to be 1:311 in the UK and 1:227 in Brazil, while the desired global average is 1:770 (Barugahara & Sebbale, 2016). Table 2 shows the number of registered professional engineers in East Africa in 2021-2022. There is, however, a particular dissonance in the status of engineering in Africa: if there is a significant shortage of engineers compared to the need, then it follows that the recent engineering graduates should quickly find relevant employment. However, that is not the case.

While there are some exceptions, East African countries in general report that a significant number of local engineering graduates have difficulty finding engineering employment (Matthews et al., 2012; Mohamedbhai, 2015b; Confederation of Tanzania Industries, 2018). The competency of engineering graduates has been called into question by some studies and reports. A survey in

2014 by the Inter-University Council for East Africa (IUCEA), which regulates higher education in East African Community countries, reported that in Uganda at least 63% of graduates did not demonstrate sufficient skills for the job market; while in Tanzania, 61% of graduates fitted the same description. In Burundi, Rwanda, and Kenya, 55%, 52%, and 51% of graduates respectively were perceived to be in need of competency building (Nganga, 2014). A 2012 Royal Academy of Engineering study (Matthews et al., 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. Relatedly, an observed practice in most African countries is that 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.

Table 2: *Number of registered engineers in East Africa*

Country	**No. of registered engineers**	**Population (millions)**	**Population per registered engineer**
Uganda	1,406	43.0	30,714
Kenya	2,586	55.4	21,425
Tanzania	7,610	62.1	8,158
Rwanda*	1,482	13.6	9,202
Burundi	15	12.4	825,264
South Sudan	—	11.4	—

Source: Alinaitwe, 2021 *Updated August 2022, from the Institution of Engineers Rwanda

It can be speculated, therefore, that this problem with engineering ecosystems in Africa is twofold: the relative deficit (real or perceived) in competency of engineering graduates in ever-advancing areas of STEM, and the limited opportunities to hone and demonstrate such competency in the labour market.

With the combination of poor institutional infrastructure, limited use of new teaching and training techniques and equipment at engineering schools, weak industry-academia linkages, and the challenges with accreditation and registration of engineers and technologists described above, there is little question that engineering education in Africa needs improvement (SADC, 2019; Sheikheldin and Nyichomba, 2019; Kraemer-Mbula et al., 2021). In general, there is a shortage of reliable EPs to meet local engineering needs (of local industries, public sector, training, consulting, etc.). The challenges are both quantitative (i.e., of size of workforce) and qualitative (i.e., quality of training).

Engineering education has been observed to yield more favourable results when practical training, being an important bridge between theory and practice, is integrated in various ways. One noticeable approach is co-curricular activities that include applying what is learned in class 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 organisations that include activities that engage students with the larger environment and society (Burt et al., 2011). Studies from North America and Europe on the outcomes of co-curricular activities in engineering education – especially co-operative training (or industrial secondments) and industrial attachment programmes – converge on several conclusions. One conclusion is that, 'When engineering students are involved in co-curricular experiences, they exhibit greater leadership skills, are more thoughtful about their ethical decisions, and can articulate how involvement influences their ethical development' (Burt et al., 2011, p. 1). Another conclusion is that with good preparation, students perform well in co-operative training/attachments to levels that satisfy both the student and the employer (Friel, 1995; Hackett et al., 1998). In addition, while such programmes and internships may cause students to graduate later than their peers who do not undertake the same co-curricular activities, their employability upon graduation tends to be higher, as well as their starting salaries (Friel, 1995; Kotys-Schwartz et al., 2011). Furthermore, some studies showed that companies that engage in well-structured co-operative programmes tend to praise the experience, and refer to both qualitative and quantitative benefits of these programmes, for example that these programmes reduce training costs of newly-hired graduates because they already know a good deal about the company and operations from their previous experience; and that SISs help in diversifying future employees as well as easing them into the work environment. Friel (1995) concludes his study on the topic by saying, 'It appears that cooperative education develops a graduate that is better prepared for permanent work and helps a company identify potential new hires prior to the graduation date that may require less training' (p. 6). Other studies – in Europe and Africa – focus on curriculum design that delivers much of the same benefits of co-curricular activities, or complements them, in ways that aim to produce competent, work-ready engineering graduates. Context-based curriculum design (Case et al., 2015) and problem-based learning (PBL) (Aalborg University, n.d.) are important ideas and practices in that vein.

East African countries, and African countries at large, have had their share of implementing SIS programmes. Tanzania, Uganda and Kenya have had SIS programmes for decades, and Rwanda has recently joined them. In Zimbabwe, for example, industrial attachment programmes (IAPs) – another name for SISs – for students in Higher Learning Institutes (HLIs) have been practised since the 1980s (Dondofema et al., 2020) with reported classical benefits to students, HLIs and industries, as well as reported challenges. The latter include an overload of students relative to available industries for IAPs, mismatch of skills between students and industries, weak linkages between HLIs and industries, and difficulties of HLIs in coordinating IAPs for large numbers of students (Munyoro et al., 2016). Similar benefits and challenges to those IAPs in Zimbabwe are evident in other countries such as Ghana (Adjei et al., 2014; Nduro et al., 2015). Nigeria has the largest higher education system in Africa and has the Students Industrial Work Experience Scheme (SIWES) in which almost all universities participate, aimed at all students that study in STEM and related programmes. SIWES requires 24 weeks as the minimum duration of an IAP for engineering students to be recognised, and according to Oyeniyi (2012), it has been a relative success in increasing students' skills and utilising them in industrial development.

Yet all the above does not sufficiently explain what is missing in our understanding (and attempted remedies) of the twofold problem mentioned above. We may need to understand the contexts better through more information, observation, and synthesis.

Approach and methodology

The study was carried out in three main phases: (I) surveying some SIS best practices in East Africa and other developing countries; (II) action research by piloting long-term SIS placements; and (III) synthesising the findings and widely disseminating the results to stakeholders. This was to be a study of best practices to produce evidence-based and evidence-informed policy recommendations in establishing and running robust engineering SIS programmes coordinated between universities and industries – and perhaps with support from the public sector – to serve both the industries and students. While there are currently sporadic cases of SIS placements in various university programmes, clear, broad and standardised programmes with visible outcomes are yet to be found.

The main objectives of the study included: (a) gaining reliable knowledge and understanding, through policy learning, of the potential of tertiary SIS programmes in strengthening engineering ecosystems in East Africa, and (b) examining selected best practices in SIS pedagogical approaches, through initiating, monitoring and evaluating SIS placements. In general, the study aimed to shed light on the problem of dissonance between the recorded shortage of engineers in Africa, on the one hand, and prevalent unemployment (and underemployment) of engineering graduates on the other, and to improve our understanding of peculiarities and possible remedies for the purpose of advancing the sustainable development goals.

The study's approach was based on a 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 have not been touched directly (Meadows, 2010, 2012). The research team postulated that promoting engineering SIS programmes can be a suitable approach to strengthening the linkage between engineering study, practice and employability. If such an outcome is achieved – through curriculum change and policy support – it can, in turn, increase student enrolment in engineering schools, as a response to increased employability of engineers after graduation. From an engineering ecosystem perspective, it is critical to understand that engineering academic programmes and engineering jobs in local industries are tied together by the flow of information and technology, through human resources as well as knowledge, including economy/market feedback. We understand these relations as feedback loops that influence each other's own dynamics through information flow, rules and connections of the whole system. This type of system is a 'technosocial system', where people and technologies work in combined efforts that form functional wholes (Woodhouse & Patton, 2004). The study's objectives followed a theory of change illustrated in Figure 1.

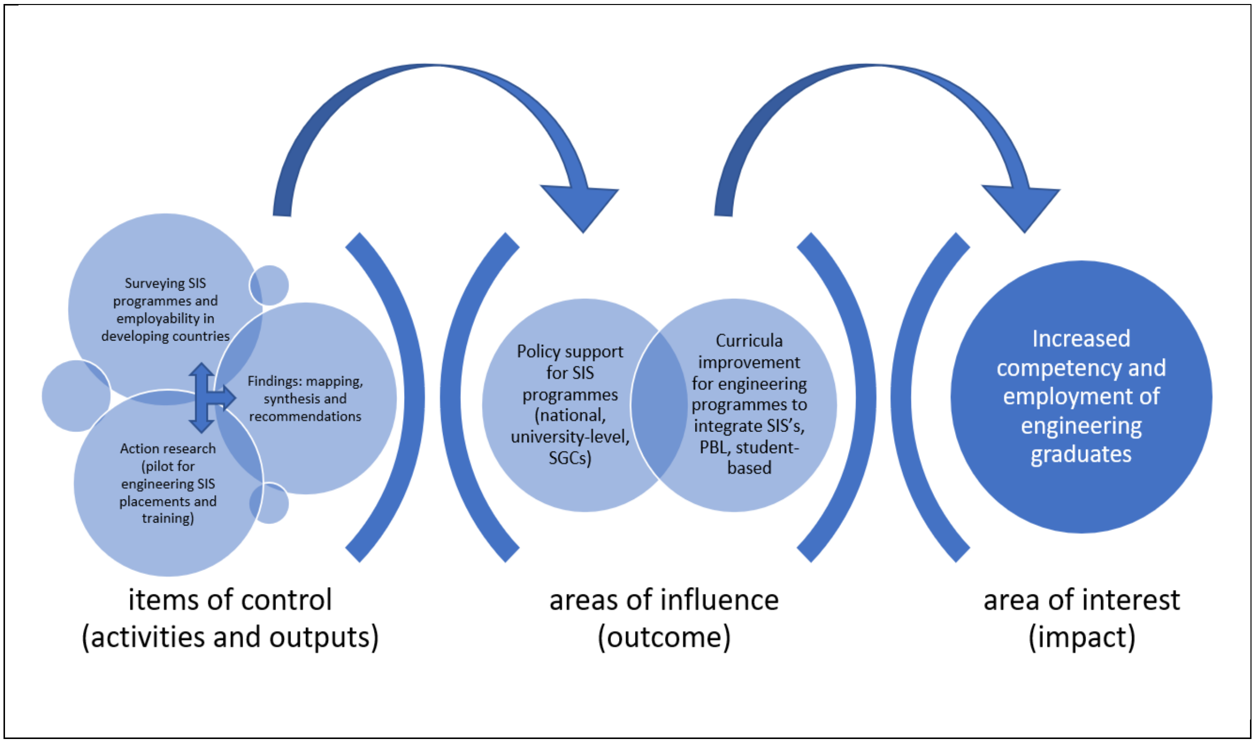


Figure 1: *SIS Project theory of change*

In phase I of the study, we carried out two complementary activities. The first activity was a survey of the four East African countries of Tanzania, Kenya, Uganda and Rwanda in terms of previous and current experiences of engineering, undergraduate SIS programmes, and any of their visible outcomes, and identifying best practices among such programmes (if existent within East Africa), as well as other comparable and relevant best practices known in other countries from the economic South. The third activity was to identify partner universities for the pilot phase and finish selecting students. For phase I we used key informant interviews (using semi-structured interview guides) with academics, industry associations and policymakers (such as science councils and engineering boards). We also consulted public documents (published by industries, academia and government), such as tracer studies of engineering graduates and annual reports from industry confederations. We were able to collect information with more depth from Tanzania (interviewing key informants from engineering-related industries in Dar es Salaam, Arusha, Mbeya and Morogoro, four universities, the Confederation of Tanzania Industries, the Commission for Science and Technology and the Engineering Registration Board) while we had to stop at general meetings with academic deans and science council representatives in Uganda and Rwanda, as well as with (not very) publicly-accessible information. In Uganda, we had general meetings with Makerere University's engineering faculty, and with senior staff at the National Council of Science and Technology, in which we were provided reliable and documented information and public reports such as the Ugandan tracer study of engineering graduates (Barugahara & Sebbale, 2016). In Rwanda, we were also able to rely on publicly available information acquired through general meetings with faculty staff from the University of Rwanda (UR) and personnel of the National Council for Science and Technology, especially as one of the co-authors of this paper is an engineering faculty member at UR and was a partner in phase II of the project, and because Rwanda has a number of public reports covering most of the information we were looking for. In Kenya, colleagues at the Africa Centre for Technology Studies, a partner research organisation, were able to collect relevant data on our behalf since they are operational in Kenya and the scope of the study was relevant for them.

In phase II (the pilot study), four students were selected from two partner universities in East Africa: the University of Dar es Salaam (College of Engineering and Technology) and the University of Rwanda (College of Science and Technology). Faculty advisors from each college selected two students for SIS placements for one year in engineering entry-level or apprenticeship positions in suitable industries. The students had just completed their junior year (i.e., one year left to graduate). SIS placements included stipends (comparable to salaries of entry-level engineering graduates in their respective countries). Of the four selected students, three were female and one was male. The SIS placements differed from the usual practice in the region. They were to be long-term – almost one academic year – and they were to be with employee-level responsibilities. Each university received a budget from the project funding that covered student stipends and administrative costs.

Findings

There appears to be consensus that existing SIS programmes in East African countries are not only similar but also do not work well, and for the same reasons – mainly insufficient industrial attachment periods, the overwhelming number of students compared to the number and size of industries available to place them, and the mismatch of skills and work in SISs.

General findings from phase I

Similarities were observed across the four countries regarding experiences with student industrial training programmes and initiatives (the models, the challenges, and feedback and perspectives of stakeholders). The SIS models are the same and have been so since engineering departments were established in most of the East Africa region. According to academic interviewees, these programmes worked well in the past, with a limited number of engineering students and effective involvement of the public sector in securing relevant SIS experiences. Currently, the circumstances have generally changed, but the models have remained the same. One reason is that the number of students has increased dramatically, and many university colleges (non-engineering or 'professional degrees') began to seek industrial training for their students as well, thus overburdening industries as they did not increase in number and capacity in proportion to the increase in student numbers. Overall, however, it must be noted that there was weak documentation of past and present SIS programmes (or industrial training/attachment programmes), which made the study rely more on qualitative data and observations than originally intended. Most of the stakeholders we met could not offer more than verbal information, and occasionally basic documents.

The overall findings from phase I are: (a) all four countries are technically familiar with SIS programmes, except that they have not changed over time as the environment changed, especially in terms of the increase in the number of engineering students without a corresponding increase in local industries; (b) and partly due to (a), it became more difficult to manage SIS programmes for both university faculty and industry supervisors, which eventually led to SIS programmes with weak structure and limited hands-on training; (c) most stakeholders (academia, industry, government, students) are generally aware that current SIS programmes have significant shortcomings that markedly minimise their potential benefits; and (d) the unavailability of, or weak access to, documentation of SIS experiences to date made it a challenge to perform a rigorous investigation to make informed decisions that could improve the status quo.

Tanzania. In Tanzania, annual practical training periods of eight weeks, except for the final year, are standard in all Tanzanian HLI engineering schools. Industries are required by the state to accept students for these periods. After the first year of engineering study, students undergo their first practical training period as artisans (i.e., with tasks at artisan levels); after the second year as technicians; and after the third as engineers. These placements that progress the expected skill levels were designed to enable the engineering students to experience, hands-on, the various, connected, and important levels of engineering practice. However, criticism is emerging from faculty, students and industries, with high consensus, that few students and industries benefit from such training due to overcrowding (as even other schools/disciplines have practical training programmes around the same period) and the short period of training. On average, 2,500 students from Dar es Salaam Institute of Technology (DIT), and 1,800 students from University of Dar es Salaam (UDSM) do practical training annually, all spread across about 200 industries, public and private; however, normally not all students get placements, so on average around 120 industries participate each year. The number is overwhelming, and the capacities of industries are both limited and spread thin. Another constraint is that all other non-engineering final-year students (from business, management, earth sciences, etc.), or students from other fields from other universities, also attend practical training placements and at the same time of the year, resulting in even more crowding. Table 3 (in the appendix) provides feedback from industry partners about the current state of SIS programmes in Tanzania.

In the past, UDSM had the only engineering programmes in the country. Engineering students were few and the main industries known. Besides, most graduates were recruited for jobs, or further studies, before graduation. Smaller classroom size and relatively fewer industries allowed for focus and enabled decision makers to place almost all the graduates, who were also fully funded. Also, at UDSM, from the 1980s to early 1990s, students were allocated employers (state-owned enterprises or parastatal organisations) by their third year, where they would go for their eight-week practical training and where they would work after they graduated. Today, Tanzanian registered engineers form 63% of registered engineers operating in all of East Africa and they work all over the East African Community (EAC) (Barugahara and Sebbale, 2016, p. 41). This could be seen as a testimony to Tanzania's engineering education and certification quality compared to the rest of the region. However, Tanzania has about 60 engineering practitioners per 100,000 persons, a low number among the Southern Africa Development Community (SADC) countries (SADC, 2019). Yet in 2015, activities involving engineering contributed as much as 63.8% to total GDP. Activities involving engineering include agriculture, construction, manufacturing, electricity, gas, water, mining operations, transport and communication (SADC, 2019, p. 8). That means that engineering-related activities are important for the Tanzanian economy, and that improvements to the national engineering ecosystem would be desirable for overall economic development.

Rwanda. Rwanda has recently embarked on enhancing the STEM capacity of the country at large, with most public funding being directed towards STEM institutions, and it has also invited many international institutions to establish educational and research posts in the country (UNCTAD, 2017). That focus also includes providing practical training opportunities for engineering students as well as implementing policies to normalise workplace training for TVET level graduates. At the University of Rwanda, engineering students are provided practical training in their workshops as part of the curriculum (e.g., machine tools, welding, carpentry, electronics, appropriate technology) in addition to an industrial attachment programme that is a compulsory credit-rated module for every specified degree programme at the College of Science and Technology. This industrial attachment is typically assigned after the student completes the third year and it lasts for 10 weeks, quite similar to practical training and field attachment placements in Tanzania and Uganda, with some variations. Challenges of the industrial attachment programme also seem to be similar to those in Tanzania and Uganda, and they include difficulty in finding proper industry placements for students, problems with funding and students' welfare during attachment periods, constraints in finding time and resources to monitor and supervise students sufficiently, and students' lack of motivation in maximising learning benefits from the attachments. Table 4 (in the appendix) presents a general comparison of the status of SIS programmes in Tanzania and Rwanda's principal universities: UDSM and UR.

A 2014 tracer study of graduates from HLIs in Rwanda found that 'graduates from Economics and Business, Education and Arts and Social Sciences are over-produced vis-à-vis other fields like Medicine, Engineering, and ICT' (Republic of Rwanda, 2015, p. ix). In 2014, based on data from 2012, a World Economic Forum Executive opinion survey ranked Rwanda as number 74 (out of 148) in the world in terms of the availability of scientists and engineers, and the country ranked 125 in objective measurements of enrolment in tertiary education (UNESCO, 2015). Between 1996 and 2013, 6,180 students graduated from HLIs in Rwanda with an engineering degree. Overall, the country had a 15% unemployment rate, and 'there appear[ed] to be lack of sufficient formalised synergies and partnership between public and private employment agencies with HLIs. As a result, relevancy of internships and acquired skills to the labour market were rated weak' (UNESCO, 2015, p. 114). Weaknesses were also noted by employers among graduates in the areas of hard skills in areas of research and problem-solving skills. According to UNCTAD (2017, p. 21), 'each year, 1,400 engineering students successfully graduate. In [2016] 300 had found a job in government structures and 200 in the private sector, while the others are searching for a job, and this in spite of an unresolved skills gap.'

Uganda. In Uganda, and contrary to other East African countries, a tracer study of engineering graduates showed that most of them end up working in their field (or related to their field). For Uganda, it seems that studying engineering remains a good choice for graduates in terms of employability (Barugahara & Sebbale, 2016).

> Most engineering graduates (74.6%) found their first job less than a year after graduation. This could be because 61.9% searched for engineering related jobs, three years prior to graduating. In this survey, 78.8% of engineering graduates were employed while 3% and 0.6% were either unemployed or inactive respectively [while] 72% of engineering graduates described their current occupation as being "closely related" to their undergraduate training (Barugahara and Sebbale, 2016, p. iii).

These findings shed a positive light on the status of engineering education and employment in Uganda. Yet problems in the industrial training programme persist. Similar complaints to those in Tanzania, of fatigue in the programme, where students, faculty and industry are not sure of its benefits, show that industrial training works on paper as a requirement that has to be fulfilled, while a fair assessment may reveal an unfavourable situation. In the past, Makerere University had the only engineering programmes in the country. Just like UDSM in Tanzania, engineering students were few and the main industries were known, and most graduates were recruited for jobs or further studies before graduation.

Other aspects require revisiting, however. For example, 91.7% of the engineers were not formally registered, according to the tracer study: 'The number of registered engineers in Uganda is still low compared to the other countries in the East African Community (EAC). Kenya has a register of 1,400 engineers which is twice that of Uganda. (By 2015, Uganda had a register of 772 engineers of whom 494 were in practice.)' (Barugahara and Sebbale, 2016, p. 41). The main reason cited was that they lacked minimum requirements for registration. Far fewer females in particular were registered engineers. The value of registering, and how it pushes engineering practitioners further in their engineering careers, may need to be promoted, the tracer study adds, since it is required for being considered in many engineering jobs and responsibilities. And like Tanzania, although there are higher numbers of engineers in the population, 'Uganda still has one of the smallest per capita ratios of engineers per population' (one engineer per 53,000 people)' (Barugahara & Sebbale, 2016, p. iv). Moreover, fewer engineers were involved in traditional mechanical/manufacturing and agricultural fields, which are critical fields for national industrial development.

Kenya. In Kenya, and like Tanzania and Uganda, engineering colleges and universities also conduct students' practical training through placements and attachments. The time allocated for the field attachment is between eight and twelve weeks, depending on the course programme. University curricula require the second-year students to go for internal (in-school) hands-on training for two weeks and third year and fourth year students to go for external placements. Several challenges in industrial training programmes have been identified in Kenya. Although students are evaluated by industries as having strong hard engineering skills, they complain that students lack soft skills (such as effective communication and teamwork). Secondly, supervision is limited in following up students' performance, and the decrease was explained by the increasing number of students to supervise. The University of Nairobi, for example, registers around 290 students who go for placements per year against 20 supervisions at different student placements. Similarly, the number of industries cannot comfortably accommodate the increasing number of students in Kenya.

4.2. Findings from phase II (SIS placements)

In summary of phase II findings and observations, students, industrial supervisors and academic supervisors reported a positive return from the SIS placements that took place in this study. The highlights from the student reports, with faculty and industrial supervisors' comments, show similarities in two aspects: a) increase in employable skills: all reports highlighted an increase in hands-on skills and understanding of practical/work environments; and b) increase in confidence: comparing the level of confidence in their skills from the point when they began the SIS placement to the point when they finalised their placement, reports showed that the students had gained significant confidence in their ability to secure employment after graduation, in addition to a similar increase in confidence from their faculty and industrial supervisors. Overall, the students had either secured placements (as soon as they graduated) or were more confident in their ability to find the right channels and approaches to secure employment after graduation. Table 5 (in the appendix) summarises lessons drawn from the pilot study (phase II).

Overall, while the experiences were positive, the fact that they were only pilot placements may have not allowed for experiencing a more structured, systematic and well-planned SIS programme. In these pilot projects the students and their industry supervisors had to fill the SIS experience with work, and they did that well, but it made them think about how it would have been more rewarding and educational if they had been more prepared in terms of specifying the students' tasks and outputs, and in terms of setting a standard SIS programme to follow.

Additionally, some ideas emerged after recognising the benefits of long-term SIS programmes, such as the suggestion by a senior UDSM professor of incorporating longer SIS placements by changing the structure of current practical training/industrial training programmes – for example, combining 3-year practical training periods to make a longer SIS term (a semester or more).

Discussion: engineering ecosystems and leverage points

The problem of dissonance between shortage of engineers and unemployment of engineering graduates, as explained above, can be traced to gaps in capacities and policies. A way of looking at the problem is to approach it with the frame of 'engineering ecosystems' (Klassen & Wallace, 2019; Sheikheldin & Nyichomba, 2019). The notion of 'ecosystem' implies things such as multiple actors with interdependency between them and the important role of systems aspects such as communication channels, feedback loops, timeframes, unintended consequences, and so on. We can consider engineering ecosystems as technosocial systems that are broad and interlinked.

The four East African countries share many similarities, in history and in current challenges in university-industry interlinkages, making them a good example of a 'regional engineering ecosystem' that exists alongside national ecosystems. Considerable evidence exists for the existence of systems phenomena, such as feedback loops, system delays, and possible leverage points. In this study, cases were observed of systems delays in response to changes in the engineering scene. For instance, changes in the number of engineering graduates did not change old SIS policies, and also there were delays in policies regarding absorption of engineering practitioners in the job market and adjusting to new needs and numbers. We can also expect that changes in curricula, or training of instructors in PBL, will only show outcomes some years after implementation. Several feedback loops could be identified as well, demonstrated in Figure 2 below.

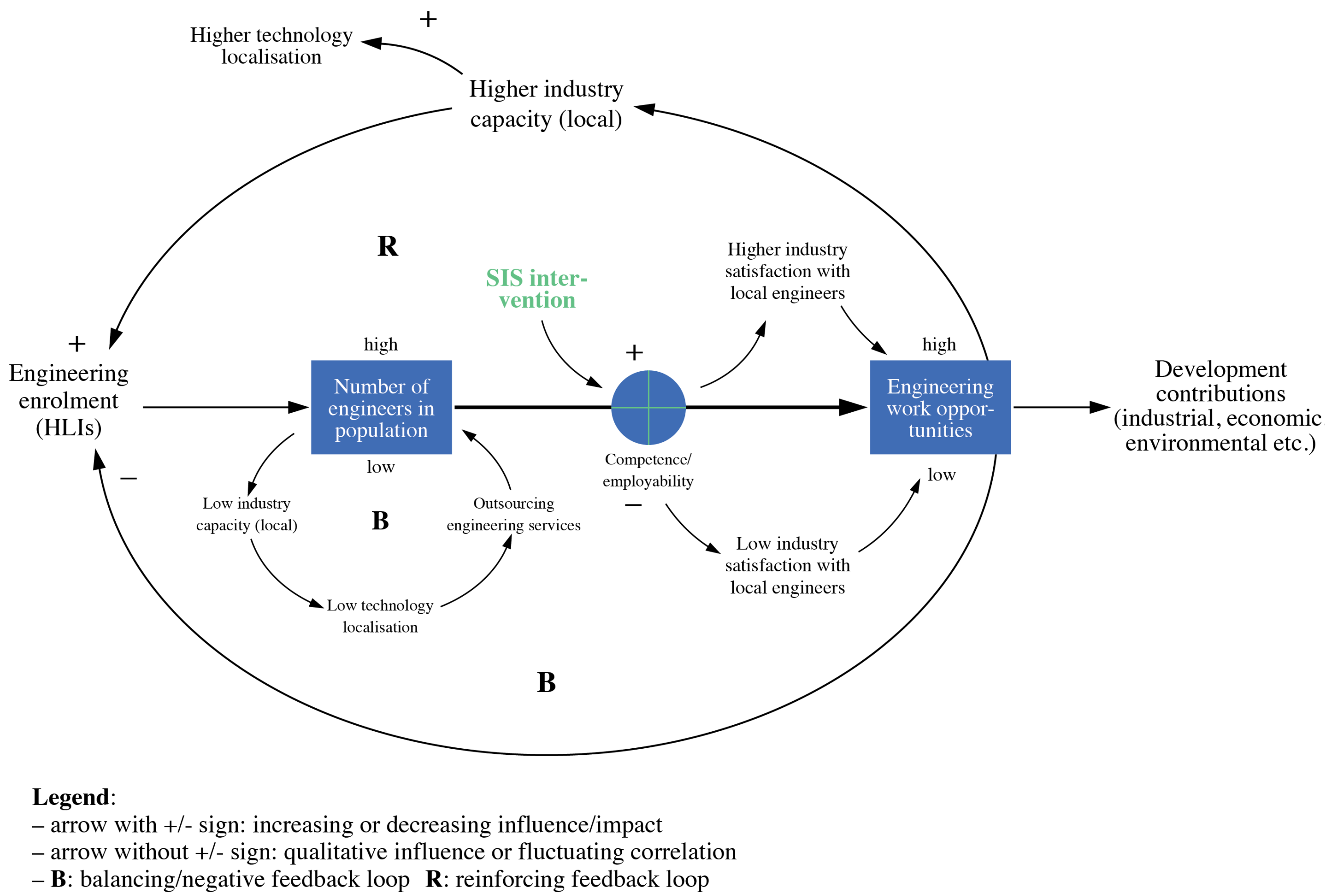


Figure 2: *A systems dynamics diagram (stock and flow + feedback loops) of relations between the number of engineers and work opportunities in a country, with competence/employability being the regulator or bottleneck of flow between the two.*

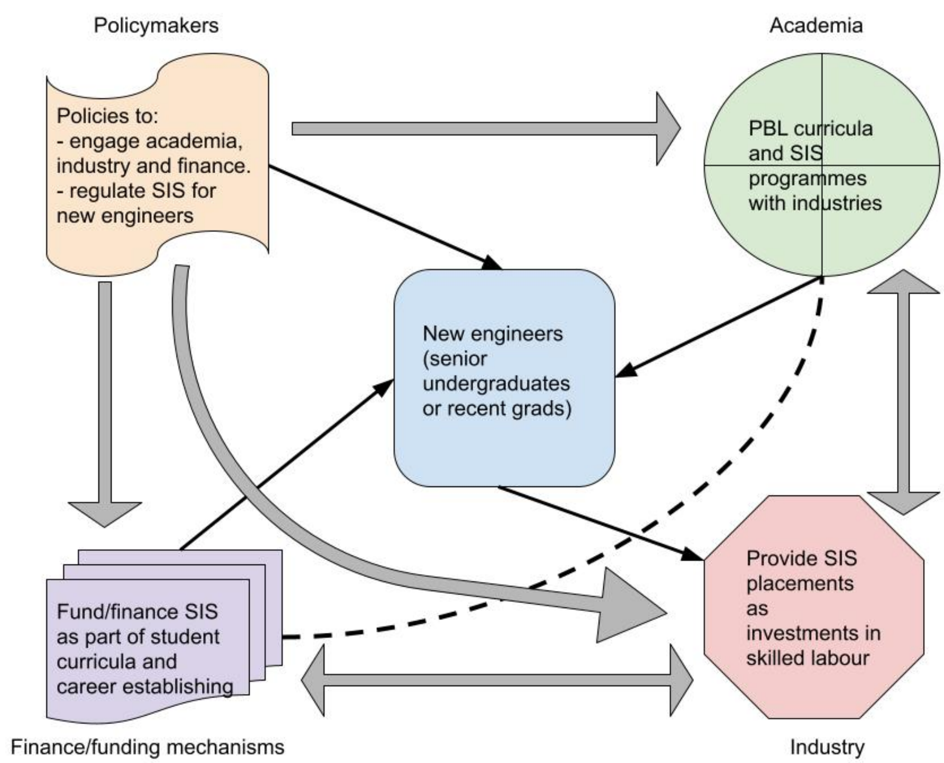
Combining two systems modelling tools (stock and flow diagrams, and feedback loop diagrams), Figure 2 portrays reinforcing and balancing relations between several elements and processes, as they relate mainly to the flow between two stocks: the number of engineers in the population and limited engineering work opportunities. With competence/employability being the valve, or bottleneck, of that flow, as proposed in this paper, the relations can change with the intervention of SIS and similar programmes as a leverage point in the system, as also proposed by the paper.

It is important to note, from the outset, that the diagram has limitations of representation. First, such diagrams emphasise change over time, which implies delays in the effects (of any interventions) that are not captured with precision in the diagram. Second, it focuses on what SIS can bring in change to the system, as a leverage point, but it does not cover other aspects that influence work opportunities and number of engineers, such as economic investment in engineering education and engineering projects, for example.

Other leverage points may exist in policies: standardising long-term, hands-on SIS placements across the triple helix (state-academia-industry) could lead to strengthening the local engineering ecosystem (i.e., advancements in industry, registration of engineering practitioners, and technology localisation). Yet there might be bigger leverage points, at the level of paradigms – perhaps such research points to bigger issues of perceiving engineering practice in developing countries. We can rethink academic engineering training as parallel to the development level of the country, instead of thinking of engineering training as only relevant when up to standards of industrialised, technologically advanced, countries (as is the case now). The four main influencers/actors of engineering ecosystems (policymakers, universities, industries, and financing/funding mechanisms) could introduce new, more conducive paradigms.

Figure 3 (below) provides another visualisation: that of the main actors and connections of the engineering ecosystem if new engineers (i.e., senior undergraduates or recent graduates) are taken as the centre of attention. The visualisation was developed over the project's period, based on the literature, survey and pilot, but it is still in need of further examination and consultation. In this ecosystem, policymakers play a critical role, and they include regulatory bodies for engineering practice as well as other actors from the state or from regional bodies (such as science councils). Academic institutions also play a major role, particularly when they choose to innovate and tailor their programmes to include more PBL and SIS activities. Industries play a critical role as well, particularly when they realise that providing and organising well-structured SIS placements is an investment in future skilled labour that they need to grow and innovate.

Finance/funding mechanisms play a crucial part in the ecosystem because they can be catalysts that invest in proper engineering training to get returns in the form of more capable engineering practitioners (in quality and quantity) who advance and improve the ecosystem at large, for sustainable development goals.



Legend:

↗ from-to inputs (bolder lines between institutional actors)
---- inter-influence (various relations)
↔ indirect influence (through policy or relation)

Figure 3: *Engineering ecosystem influencers/actors and employability of new engineers*

Employability – for engineers and others – can be generally understood as having the set of knowledge, skills, understanding and attributes to gain and sustain fulfilling work. With such understanding/definition in mind, all existing evidence supports the argument that SIS programmes (and co-curricular activities in general) increase the employability of students. Yet there are supporting approaches that should be implemented – for example, linkages with industries should be a reality, not an aspiration, and pedagogical approaches such as PBL are instrumental in realising these linkages.

In summary, we may think about it in simplified terms: if the competency of engineering graduates in Africa is increased through enhancing and strengthening engineering education, then the employability of those graduates would likely increase, thus making an engineering degree more attractive for incoming college students, eventually leading to an increase in the number of engineers. Finally, a general understanding is growing that policy is the catalyst of possibilities. To have broad and long-lasting impacts on engineering education in Africa, for the sake of sustainable development and growth, solutions should be articulated as policies – formulated, implemented, embedded and supported.

Conclusions

General characteristics and patterns were revealed through this study about the challenges of university-to-employment transition for engineering students in East Africa. The four East African countries of Tanzania, Rwanda, Uganda and Kenya share similarities in history and current challenges and interlinkages, making them an example of a regional engineering ecosystem that exists alongside national ecosystems. There is consensus that the short-term (8-12 week) industrial attachments currently practised do not allow most students to have the in-depth industrial experiences that enhance their employability skills. In addition, industries tend to receive more students in each training period than they can give tailored attention to, resulting in the latter completing industrial attachments with little experience and only fulfilling formal requirements to graduate. Weak coordination between universities/colleges and industries also contributes to a general mismatch of placements and miscommunication about how SISs can be improved to increase the employability of engineering students. Stakeholders – faculty, industry supervisors and students – agree that long-term SIS placements (for example, 6-12 months) help increase the employability of engineering students, but further evidence is needed (more scale SIS placements and more tracer studies). While long-term goals lie in the increased number of industries that require skilled employment, short-term mitigations may lie in universities giving existing industries room by arranging SIS programmes at different time periods.

A systems approach points towards a need for recognising feedback loops and delays in engineering ecosystems as they respond to a twofold problem: the relative shortage of engineering practitioners and the limitations to employability for current practitioners. Pedagogical approaches that foster strong academia-industry linking, such as SIS and PBL, may resolve such dissonance (i.e., possible leverage points in the ecosystems), and can be effected through policies that act as change catalysts.

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References

Aalborg University. (n.d.). *Problem Based Learning (PBL)*. Aalborg University, Denmark. PBL.AAU.DK

Adjei, N. A. K., Nyarko, D. A., & Nunfam, V. F. (2014). Industrial attachment in polytechnic education: An approach to polytechnic-industry nexus in human capital development of selected polytechnics in Ghana. *Journal of Education and Practice*, *5*(33), 33. https://ssrn.com/abstract=2518991

Alinaitwe, H. (2021). *Dynamics of demand and supply of engineering professionals – making our engineers work for industrialization in Africa*. In Workshop: engineering education capacities-how engineering ecosystems are preparing students in Africa for employment, Dar es Salaam, December (Vol. 1).

Barugahara, I., & Sebbale, S. (2016). *Tracer study of engineering graduates in Uganda: An expedition from university to work*. Uganda National Council for Science and Technology (UNCST).

Beaudry, C., Mouton, J., & Prozesky, H. (Eds.). (2018). *The next generation of scientists in Africa*. African Minds.

Burt, B., Carpenter, D., Finelli, C., Harding, T., Sutkus, J., Holsapple, M., Bielby, R., & Ra, E. (2011). *Outcomes of engaging engineering undergraduates in co-curricular experiences*. American Society for Engineering. https://deepblue.lib.umich.edu/handle/2027.42/86117

Case, J., Fraser, D., Kumar, A., & Itika, A. (2015). The significance of context for curriculum development in engineering education: A case study across three African countries. *European Journal of Engineering Education*, *41(3)*, 279-292. https://doi.org/10.1080/03043797.2015.1056103

Cebr & Royal Academy of Engineering. (2016). *Engineering and economic growth: A global view*. Royal Academy of Engineering.

Richard, R. (2018). *Identification of the skills gap for innovation and successful industrial development in Tanzania*. Confederation of Tanzania Industries.

Despres-Bedward, A., Ibrahim, N., & Newfield, K. (2015). *Engineering education for sustainable cities in Africa*. Proceedings of the Engineering Education for Sustainable Development Conference (4-7 September 2016, Bruges, Belgium).

Diyamett, B., Ngowi, P., & Mutambala, M. (2012). *Foreign Direct Investment (FDI) and local technological capabilities in the manufacturing sector in Tanzania.* (Policy Brief 2-2012.). STIPRO. https://stipro.or.tz/wp-content/uploads/2018/11/Foreign-Direct-Investment-Manufacturing.pdf

Dondofema, J., Mwenje, J., & Musemwa, L. (2020). The Industrial Attachment Programme - history, benefits, challenges and its adoption in Zimbabwe: A review. *Asian Journal of Education and Training*, *6*(3), 412–420. https://doi.org/10.20448/journal.522.2020.63.412.420

Friel, T. (1995). Engineering cooperative education: A statistical analysis of employer benefits. *Journal of Engineering Education*, *84*(1), 25–30. https://doi.org/10.1002/j.2168-9830.1995.tb00142.x

Hackett, R. K., Martin, G. R., & Rosselli, D. P. (1998). Factors related to performance ratings of engineering students in cooperative education placements. *Journal of Engineering Education*, *87*(4), 455–458. https://doi.org/10.1002/j.2168-9830.1998.tb00379.x

Klassen, M., & Wallace, M. (2019). Engineering ecosystems: A conceptual framework for research and training in sub-Saharan Africa. Proceedings: 7th African Engineering Education Association international conference, Lagos, Nigeria.

Kotys-Schwartz, D., Besterfield-Sacre, M., & Shuman, L. (2011). *Informal learning in engineering education: Where we are – Where we need to go*. Proceedings of the Frontiers in Education Conference, 12-15 October. https://doi.org/10.1109/FIE.2011.6142836

Kraemer-Mbula, E., Sheikheldin, G., & Karimanzira, R. (2021). Southern Africa. In S. Schneegans, T. Straza, & J. Lewis (Eds.), *UNESCO science report: the race against time for smarter development* (pp. 534-573). UNESCO.

Kumar, A., Ochieng, A., & Onyango, M. (2004). Engineering education in African Universities: A case for internationalization. *Journal of Studies in International Education*, *8*(4), 377–389. https://doi.org/10.1177/1028315304269136

Matthews, P., Ryan-Collins, L., Wells, J., Sillem, H. & Wright, R. (2012). *Engineers for Africa: Identifying engineering capacity needs in Sub-Saharan Africa*. A summary report. Royal Academy of Engineering.

Meadows, D. H. (2010). Leverage points: Places to intervene in a system. Meadows, D. H. (2010). Leverage points: Places to intervene in a system. https://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/.

Meadows, D. H. (2012). *Thinking in systems: A primer*. London: Earthscan

Mohamedbhai, G. (2015a). Engineering education in Sub-Saharan Africa: Quest for quality. *International Journal of African Higher Education*, *2*. https://doi.org/10.6017/ijahe.v2i1.9259

Mohamedbhai, G. (2015b). Improving Engineering Education is Sub-Saharan Africa. International Higher Education, 80, https://doi.org/10.6017/ihe.2015.80.6155.

Mohamedbhai, G. (2017). The importance of polytechnics for Africa's development. *International Higher Education*, *88*, 30–31. https://doi.org/10.6017/ihe.2017.88.9695

Mohamedbhai, G. (2021). *Engineering practitioners in Sub-Saharan Africa: Demand, supply, capacity and quality*. In Workshop: engineering education capacities – How engineering ecosystems are preparing students in Africa for employment, Dar es Salaam, December (Vol. 1).

Munyoro, G., Nyandoro, Z., & Musekiwa, M. (2016). An evaluation of the Student Industrial Attachment Programme in Zimbabwe: A case study of Chinhoyi University of Technology. *IMPACT: International Journal of Research in Business Management (IMPACT: IJRBM)*, *4*(8), 1–16.

Nduro, K., Anderson, I. K., Peprah, J. A., & Twenefour, F. B. K. (2015). Industrial training programmes of polytechnics in Ghana: The pertinent issues. *World Journal of Education*, *5*(1), 102-113. https://doi.org/10.5430/wje.v5n1p102

Nganga, G. (2014, May 23). Survey finds most East African graduates 'half-baked'. *University World News*. https://www.universityworldnews.com/post.php?story=20140523130246934

Oyeniyi, A. A. (2012). *Students' industrial work experience scheme (SIWES) and the incidence of occupational misfit in Nigeria*. Industrial Training Fund. https://files.eric.ed.gov/fulltext/ED533330.pdf

Republic of Rwanda. (2015). *A tracer study of graduates from Higher Learning Institutions (HLIs) and employers' satisfaction of graduates' competences*. Higher Education Council.

Sheikheldin, G., & Nyichomba, B. (2019). Engineering education, development and growth in Africa. *Scientific African*, *6*, e00200. https://doi.org/10.1016/j.sciaf.2019.e00200

SADC (Southern African Development Community). (2019). *Engineering numbers & needs in the SADC region*. The Southern African Development Community Secretariat.

UNCTAD (United Nations Conference on Trade and Development). (2017). *Science, technology and innovation policy review: Rwanda.* UNCTAD/DTL/STICT/2017/8. UNCTAD.

UNESCO (United Nations Educational Scientific and Cultural Organisation). (2010). *Engineering: issues, challenges and opportunities for development*. UNESCO. CSIR https://researchspace.csir.co.za/dspace/handle/10204/5055

UNESCO. (2015). Mapping research and innovation in the Republic of Rwanda. G. A. Lemarchand & A. Tash (Eds.), *GO→ SPIN Country profiles in science, technology and innovation policy, vol. 4*. United Nations Educational, Scientific and Cultural Organization.

UNESCO. (2021). *Engineering for sustainable development: Delivering on the sustainable development goals*. UNESCO.

Woodhouse, E., & Patton, J. W. (2004). Introduction: Design by society: Science and technology studies and the social shaping of design. *Design Issues*, *20*(3), 1–12. JSTOR.

Appendix

Table 3: *Summary of feedback from industry partners about current state of SIS programmes (Tanzania)**

Organisation	TANELEC (electric equipment)	Confederation of Tanzanian Industries (CTI) (Richard, 2018)	TEMDO	CAMRTEC
SIS/internship existence	Yes	Yes	Engineering students are supervised by engineers at TEMDO. They are introduced to TEMDO (orientation), and then they are assigned their jobs and supervisors. The same training as UDSM (first year artisan, second year technician, and third year engineer).	When students come here, they feel estranged and challenged. Making the students deal directly with the technological creation work takes them away from the classroom environment to face real-world challenges. More of that is required.
Students received for training (annually)	About 12–15 every year	N/A (but with members of CTI)	Sometimes we get more than 10 students every year (roughly) from all the PT levels. They come from UDSM, SUA, ATC, DIT, etc.	Every year, over 50, but they usually come in groups of 20s or so per season.
Are some students employed after PT with the same organisation?	Yes, currently [we] have three students from UDSM (graduates) as our employees.	Yes, experiences of member industries that take students as interns after they graduate, for about a year – some are employed.	— (employment through public sector)	— (employment through public sector)
General assessment of current state of SIS (problems/challenges and university-industry linkages)	- Some students are useful to have, but some students are a burden. - Our resources and capacity limit the number of students we can receive. - Many of the students find our work here quite new and interesting.	Currently, there is a skills development levy of 4.5% of basic pay of all employers (higher than most countries around), so the industries feel that they are already contributing to skills development in the country and without benefit.	Staying longer (in the SIS) will make the student learn more. At 2nd and 3rd year they need to be guided to understand how to deal with design challenges and be more accurate.	Not enough time for them to actually master any part of the process. They end up covering a little of everything, making them versed in nothing. Also, teaching them is a challenge, because there is a lot that they do not know.

*Information drawn from survey that included public documents and semi-structured interviews with leaders/representatives from each organisation.

Table 4: *Status of SIS programmes in Tanzania and Rwanda's principal universities**

Institute	CoET (College of Engineering and Technology) University of Dar es Salaam	CST (College of Science and Technology) University of Rwanda
SIS/internship existence	Practical training every year for 8 weeks (1st, 2nd and 3rd year degrees – artisan, technician, engineer).	Currently, both students and faculty have mandatory industrial attachment placements, coordinated and executed with industries.**
Overall number of graduates	Graduates of CoET are on average 600 a year. On average CoET has 2,400 students enrolled (all years) every year.	600 to 1,000 graduates every year (engineering)***
Students in training (annually)	Average 1,800 per year	Average 500-1000 students per year
Industries involved with institute	Over 200 industries, but normally not all would get placements every year, so on average around 120 industries per year.	Ministry of Infrastructure: there is a clause for all foreign companies to include students and faculties for industrial training.
Problems/challenges with existing industrial SIS programmes	(1) Industries have little time to help PT students with questions. (2) PT students are not given proper protective equipment, or are given used ones (which is unhealthy). (3) On PT 3rd year, the student has to write a project on a practical problem, but one cannot have a well-executed project in only 8 weeks of placement. (4) Small allowances.	(1) Not enough industries, especially willing industries. (2) Student welfare during Industrial Attachment (IA) is minimal. (3) Budgetary constraints for staff to supervise IA student participation. (4) Guaranteeing student professional behaviour during IA requires close supervision.

*Information drawn from public records, shared by respective university faculties.
** Students at CST used go for industrial attachments after completion of 3rd year for 10 weeks. Curriculum was reviewed and now, starting from academic year 2019-2020, 2nd year students also do 10 weeks.
*** On average the School of Engineering of CST has 2,000 to 2,500 students enrolled (all years) every year, while CST has 5,000 to 6,000 students enrolled.

Table 5: *Summary of lessons and recommendations from pilot SIS placements**

	University of Dar es Salaam		University of Rwanda	
	Student 1	Student 2	Student 3	Student 4
Specialisation and year	Chemical engineering, 3rd year completed	Civil engineering, 3rd year completed	Electronics & Telecommunication Engineering programme, 3rd year completed	Civil Engineering, 3rd year completed
Industries joined (with time)	Kilombero Sugar Company Limited (November 2019 – October 2020)	Cost Plan Group (November 2019 – July 2020) and Karanga Leather Factory (August - November 2020)	Liquid Telecom Rwanda (LTR) (January 2020 – December 2020)	Rwanda Housing Authority (RHA) (January 2020 – December 2020)
Lessons for university (from student reports)	(1) Collaborate with industries (organisations and production companies). (2) More funds should be raised for sustaining the programme and engaging more students.	Get involved in identifying gaps by analysing what the university teaches and what the industry offers, and then design capacity building.	(1) Improve collaboration to facilitate students' industrial placement. (2) Pay visits to students or arrange for virtual meetings to understand what is going on. (3) Ensure that students receive their stipends timeously.	Ensure that the allocated funds for students reach them on time.
Lessons for industries (from student reports)	Need to collaborate with support institutions (e.g. SIS programme and universities). This assists in student placement and also serves as a ground for engineering graduates' mentorship and recruitment.	(1) Raise awareness of the programme; and meet students to understand their challenges. (2) Financially, invite more donors to sponsor the programme. (3) Join the SIS programme, meet the students and make clear what they expect from them.	Work in collaboration with the university in running the programme; collaborate with other industries in finding and facilitating industrial placements.	Ensure that regular supervisions are undertaken; strengthen partnership with universities and industries to facilitate the internship programme.
Lessons for SIS programme coordinators	(1) Provide information on SIS programme to more students; (2) SIS should serve as a way to advocate for reshaping the university engineering programme.	Financially, invite more donors to sponsor the programme, preferably industry to get involved in providing support.	—	Sponsor more students; work together with industries to ensure availability of placements.

*Commentaries drawn from approved student reports. Academic and industrial supervisors either commented generally or simply approved the student's report.