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16 December 2016

Evaluation of the Academy's International Industry-Academia Linkage Programmes

Appendices to the Final report

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Appendix A Enriching Engineering Education Programme (EEEP)

A.1 Description of the programme

The Enriching Engineering Education Programme (EEEP) was launched in 2013 by the Royal Academy of Engineering with funding from the Anglo American Group Foundation. The overall problem the EEEP was designed to address is the engineering 'skills gap', which is identified as a factor in holding back economic development in Sub-Saharan Africa. To this end, the programme set out to stimulate improvements in engineering curricula and teaching methods which, in turn, would ensure that engineering graduates gain industry-relevant skills and improve their employability (the programme objectives). In addition, the programme aimed to develop sustainable relationships between universities and industry and networks between engineering departments to share knowledge and best practice. Building on experience from UK programmes, interaction with industry was seen as an integral part to achieving these aims.

The pilot phase of the Enriching Engineering Education Programme (EEEP) ran between 2013 and 2015. A second phase was launched in 2016 to provide continued support for selected universities among those already involved in the pilot phase. In late 2016, the programme was renamed 'Higher Education Partnership Sub-Saharan Africa' (HEPSSA) with additional funding from the UK Government's Global Challenges Research Fund (GCRF) and a requirement to include UK partners.[1]

A.1.1 Key statistics: annual budget, success rates, changes over time

The first phase of the programme lasted for two years (2013-2015) and had a total budget of £300,000 including grants and management costs. There were two 'hub' universities selected from a shortlist of three during the pilot phase, with one or more unsuccessful institutions offered a role as 'spoke' universities. For Phase 2 (2016-), out of 12 institutions applying, five were selected for funding.[2]

A.1.2 Main implementing bodies

The Royal Academy of Engineering (RAEng) owns and manages the EEEP with funding from the Anglo American Group Foundation. RAEng has set up a steering group composed primarily of Academy Fellows, to oversee the implementation of the programme.

A.1.3 Target audience, types of participants, variations among the countries

The programme aimed to support higher education institutions in Sub-Saharan Africa. In the pilot phase, grants were awarded to two 'hubs', University of Zimbabwe and the University of Dar es Salaam in Tanzania, working with 'spoke' institutions from neighbouring countries in Southern and Eastern Africa respectively. In EEEP phase 2, hub and spoke institutions from the first phase could apply. The countries represented are Botswana, Kenya, Mozambique, Namibia, Tanzania, Uganda and Zimbabwe.

A.2 Mode of implementation

A.2.1 Key characteristics of the projects

Each EEEP project, in both the pilot and second phase, are funded for a two-year period and implemented using a 'hub and spoke' model with universities as the main beneficiaries, alongside involvement from industry partners and other local and international stakeholders.

- *Hub universities* manage the activities funded by the programme and implement the two-way staff exchanges with industry
- *Spoke universities* from the regions surrounding the hub universities participate in – and in some cases host – training workshops and benefit from the knowledge shared by hub university staff

[1] http://www.raeng.org.uk/grants-and-prizes/international-research-and-collaborations/higher-education-partnership-sub-saharan-africa/faq

[2] "Higher Education Partnerships in Sub-Saharan Africa – Applicant Guidelines", Royal Academy of Engineering, 2016

- *Industry partners* are engaged in employing university staff on secondment and supply individuals who can act as Visiting Fellows at the universities. In addition, they can contribute to workshops and give other inputs to university teaching
- *National and regional stakeholders* – including policy-makers, professional bodies and NGOs – can contribute to embedding the programme activities within the wider national context. During the pilot phase, the Southern hub involved several such bodies throughout the programme
- *International partners* are not part of the programme design. In practice, there were examples of involvement of workshop facilitators from European countries and a visiting fellow from the UK

The projects focus on higher education in the field of engineering but they have also included elements of research agenda development and project implementation.

A.2.2 The level of support available

The core programme activities included staff placements – academic and industrial staff secondments – and workshops:

- Through *secondments to industry*, university staff are exposed to current engineering practice in industry. The experience helps them to update their teaching approaches and materials to better reflect the current needs of industry. The secondments also contribute to establishing and renewing relationships with industrial counterparts. The secondees subsequently share their experiences with colleagues in their home institutions
- The *Visiting Fellows from industry* are hosted at the hub universities. During the pilot phase, they provided feedback on, and contribute to, the review of the current teaching methods and curricula, participated in workshops, gave lectures to students and staff, and provided mentoring and support for student projects
- Each project under the programme includes a series of *workshops*. These workshops allow all institutions, including Spoke universities, to learn from the experiences of the academic secondees, industry representatives or other experts and to consider how to implement positive changes in their institutions regarding the curriculum, teaching or industry relations. Specific training seminars may also be undertaken to upskill university staff

The budget for each 2-year project is up to £140,000, paid in four biannual instalments of up to £35,000 each. The programme covers the cost of living and any replacement staff needed for secondees as well as hosting and travel to workshops. Based on documentation from the pilot phase, the costs were estimated as follows: the secondments cost $1,000-$5,000 month/person; Visiting Professors from industry cost $5,000 month/person, workshops cost $250-700 per person per workshop, and staff training cost $200-300 per person.

A.2.3 Complementarity / overlaps with other local or regional activities

The EEEP is a stand-alone initiative and there is no formal coordination with other local or regional activities. The flexibility of the programme allows beneficiaries to adapt it to suit local needs. During the pilot phase, the University of Zimbabwe used the programme to develop a research strategy for the engineering faculty, which was adapted to the national policy priorities.

A.2.4 The main reasons for this mode of implementation and the advantages/disadvantages

The hub and spoke model for implementing the programme was chosen to maximise the reach of the programme with a relatively modest budget. It also gives the opportunity for institutions that are less well qualified to manage a programme on their own, to participate as spokes, learn from hub universities and build capacity for the future.[3] Several universities which were spoke universities in the first phase, were selected to lead their own 'hubs' in the second phase.[4]

[3] RAEng: "Proposal: Tertiary education programme in Sub-Saharan Africa"

[4] RAEng: "Enriching Engineering Education Programme: Phase 2 guidance notes"

A.3 Main achievements, results of the programme

A.3.1 Results, achievements of the programme

Figure 1 below lists the outputs delivered by the two hubs during the pilot phase (2013-2015). The project consortia met the headline project targets as well as implementing additional activities that were not foreseen in the programme documentation.

Figure 1 Outputs from EEEP in the Eastern Africa and the Southern Africa hubs

Types of Outputs*	Target (**)	Implemented activities	
		Eastern Africa (Tanzania)* **	**Southern Africa (Zimbabwe)*** **
Secondments of university staff to industry	**2**	2 academic staff seconded to industry for two periods each	17 secondments: 7 academic staff seconded to industry 10 technicians seconded to industry
New teaching approaches and material adopted by secondees	√	Suggestions for new courses; Industry feedback on engineering curriculum; Suggestions for student projects	New technical skills learned during secondments and subsequently applied at the university[5]
Links established with industry	√	Areas for further collaboration identified (2 secondees)	– Examples of projects following secondment
Joint industry-university project		No concrete projects as part of the EEEP	University of Zimbabwe Groundwater Project
Visiting Fellows from industry	**1**	1 Visiting Fellow from industry over two periods	2 Visiting Fellows for one period each
Lectures and seminars by visiting fellow	√	Visiting fellow contributed to at least one seminar	2 seminars by visiting fellows, and presentation at final conference
Contribution to review of teaching methods and curricula.	√	Recommendations submitted to the University	Recommendations from both visiting fellows submitted; one participated in the curriculum workshop.
Mentoring and support for student projects by industry fellow	√	Vising Fellow co-supervised four student projects contributed to BSc courses in two subjects	Visiting fellows had meetings with students and engaged with students during and after stay.
Workshops	**4**	3 workshops and the final conference	7 workshops and conferences
Updating teaching staff on industry practice	√		1 workshop with presentations from industry representatives
Training staff in up-to-date teaching methods	√	Workshop on Competence-Based Curriculum Workshop on Problem Based Learning	4 workshop hosted by the Hub university, incl. curriculum review
Knowledge sharing and dissemination	√	1 joint end-of-programme conference	1 joint end-of-programme conference
Staff training		[n/a]	1 training course for 10 staff in the use of CNC machines.
Institutional development		Plans for university incubator developed during workshop.	Engineering research agenda developed in workshop
Other outputs			5 steering committee meetings Industry familiarisation trip to Kariba with 17 participants

Source: Technopolis, compiled from *) Technopolis preliminary programme logic, **) EEEP implementation plans, ***) EEEP activity report

[5] University of Zimbabwe, Biannual report 2, July 2014, p. 5

A.3.2 Key benefits delivered to the different types of participants

The intended benefits of the programme are described below. The evaluation of the EEEP has shown that, so far, the universities and their staff have realised many of the benefits described whereas benefits to students and the wider set of stakeholder are likely to take longer to materialise.

- *Hub universities* derive benefits from staff exchanges, build relations with industry, upskill staff and build networks with other universities
- *Spoke universities* mainly participate in workshops, therefore they have the opportunity to learn from the knowledge gained by the hub universities as well as get to know new approaches to teaching and curricula development and build networks with other higher education institutions. There was also an element of capacity building for some of the spoke universities during the pilot phase, through involvement in the Southern hub's project implementation Steering Group and as workshop organisers in the Eastern hub
- *Engineering students* are the main intended beneficiaries of the programme, although they play a limited role in its implementation. They should benefit from upskilling of teaching staff, improvements in the curricula and teaching delivery, and increased exposure to industry through interaction with visiting fellows and enhanced use of relevant teaching materials derived from industry. Ultimately, this provides them with an enriched education that makes them more employable by industry upon graduation
- *Industry partners* benefit from increased interaction with universities, influencing engineering education and research agendas and potentially collaborating on projects. Ultimately, industry benefits from a supply of engineering graduates with more relevant skills

A.3.3 Impacts

During the pilot phase, the EEEP delivered clear near-term impact on teaching methods, curricular and behaviour within the participating higher education institutions: workshop participants reported increased awareness of alternative teaching and learning methods, adoption of new teaching methods and tools, with some reporting changes to curricula. Secondments enhanced personal skills, provided material for teaching and established ongoing working relationships with industry partners. The programme also enhanced networking and knowledge-sharing between institutions.

The EEEP enhanced collaboration and knowledge exchange between industry and universities. The secondments provide direct examples of this, with university staff learning from industry as well as contributing to solving problems within companies. In many cases, the secondments paved the way for creating new links and began a process of trust building between universities and companies.

The programme also brought about broader cultural and organisational changes in industry-academia relations. Organisationally, the University of Zimbabwe revived its industry advisory board as a direct result of the programme and for the University of Dar es Salaam, the EEEP facilitated the implementation an 'Innovation and Entrepreneurship Centre'.

A.3.4 Sustainability of the results

The two-year duration of the pilot programme was rather short considering the desired cultural and institutional changes. Longer-term transformational change within institutions requires continued support. There is a need build on the momentum created by the EEEP, support the further development of networking activities and extend the benefits from individual participants and departments to faculty and university wide changes. Curriculum reviews which have a large impact, are resource intensive and require support from the entire system from lecturer, university management and policy-makers.

A.4 Lessons learnt, changes over time

A.4.1 Key success and enabling factors in the approach identified

Some of the success factors from the pilot phase included:

- Buy-in from individuals with a high level of seniority within the hub and spoke universities, for example the Dean of Engineering. This helped ensure that the programme is implemented in a coordinated fashion across the faculty and that any proposed changes to teaching and curricula are taken up by university management
- Making use of existing relations with industry to facilitate initial collaboration around new activities
- Engagement with national stakeholders, such as professional associations and accreditation bodies, helps ensure that changes to engineering education are in line with national requirements and priorities

A.4.2 Main barriers overcome, possible solutions

The framework conditions in many partner countries present a key barrier to the sustainability of the programme results. There are often limited resources available locally to support and pick up changes initiated through the programme. Furthermore, many institutions lack capacity for transparent financial management of international projects. A perceived mismatch between the interests of industry and academia presents a challenge and a clear value proposition is required to convince companies of the benefit from participation.

A.4.3 Monitoring and evaluation practices and key indicators used

In the pilot phase, the signed agreements between the Academy and hub universities outlined a monitoring framework. The main monitoring consisted of biannual activity reports submitted by each of the two hub universities to the Royal Academy of Engineering. Visiting fellows and some secondees also submitted reports about their experiences. Finally, the Southern hub commissioned an external evaluation at the end of the programme.

The grant agreements contained descriptions of some indicators and metrics but they do not appear to have been used in the reporting. Monitoring and evaluation is likely to be enhanced in the future iterations of the programme.

Main sources:

- "Engineers for Africa: Identifying engineering capacity needs in Sub-Saharan Africa – A summary report", Africa-UK Engineering for Development Partnership, October 2012, available at: http://www.raeng.org.uk/publications/reports/engineers-for-africa
- "Proposal: Tertiary education programme in Sub-Saharan Africa", Royal Academy of Engineering, 2012
- "Enriching Engineering Education Programme", Royal Academy of Engineering, Brochure, available at: http://www.raeng.org.uk/publications/other/enriching-engineering-education-programme
- "Enriching Engineering Education Programme: Phase 2 guidance notes", Royal Academy of Engineering, 2016, available at http://www.raeng.org.uk/RAE/media/General/Policy/International%20activities/International%20development/Programmes/Phase-2-guidance-notes.pdf
- "Higher Education Partnerships in Sub-Saharan Africa – Applicant Guidelines", Royal Academy of Engineering, 2016, available at: http://www.raeng.org.uk/publications/other/higher-education-partnership-applicant-guideli-(1)

Appendix B African Institute for Mathematical Sciences (AIMS) – Cooperative programme, Senegal

B.1 Brief description

Although nearly one million students graduate with undergraduate degrees from African universities each year, quality tertiary education is still an issue, particularly in the scientific and technical fields.

Another issue is the low level of continuation from Bachelors to Masters or PhDs within these fields. This leads to a lack of highly skilled individuals for both the labour market and academia. Many of those who do make the decision to undertake PhDs leave the continent following graduation. This has made it difficult for Africans to produce practical scientific and technological solutions to Africa's development needs. This has also resulted in the value of maths and science degrees as an employment tool to be relegated mainly to the realm of education and there is little recognition by African governments of the potential power of mathematics to solve development issues.

The African Institutes for Mathematical Sciences (AIMS) is a network of centres which offer postgraduate training in mathematical sciences as a mechanism to help mitigate these issues. The programme seeks to provide promising students from across Africa with the means to develop as "independent thinkers, problem solvers and innovators" who can drive "scientific, educational and economic self-sufficiency" in Africa.[6]

Originally established as a single centre in South Africa in 2003, AIMS embarked on a process of expansion with the launch of the Next Einstein Initiative (AIMS-NEI) in 2009. AIMS-NEI aims to establish a Pan-African network and operate 15 centres by 2023. As of 2016, there were six AIMS centres – South Africa (opened 2003), Senegal (2011), Ghana (2012), Cameroon (2013), Tanzania (2014), Rwanda (2016) – with graduates from 42 African countries.

The programme focuses on teaching 'mathematical sciences' at Master's level as a broad foundation for the Science, Technology, Engineering and Mathematics (STEM) disciplines needed to tackle the challenges facing Africa.

As the programme has grown, the issue of ensuring students are fit for industry has moved centre stage. This has led to the development of a particular initiative in the AIMS Centre in Senegal in the form of a cooperative education programme.[7],[8] This programme is the focus of the case study as it is industry in order to improve student employability and thus has a number of parallels to the EEEP (if not in design, in expected outcome). The programme is 18 months long (the normal AIMS programme lasts for 10 months) and includes an 8-month placement in industry.

The cooperative programme in AIMS Senegal has been up and running for a year, and is a pilot programme at present. The formal objectives are to:

- Improve student's employability through formal courses and practical's in professional development and entrepreneurship
- Raise awareness of the opportunities available in industry for the AIMS graduates
- Have industry and business sector leaders contribute to the AIMS curriculum

[6] DFID business case, paragraphs 22-23.

[7] The cooperative programme forms part of a wider industry initiative of AIMS– see Appendix C

[8] One of the reasons for piloting this in the Senegal AIMS Centre was due to the labour laws which allow African students from the West African Economic and Monetary Union region (Benin, Burkina Faso, Mali, Bissau Guinea, Senegal, Togo, Côte d'Ivoire, Niger) to work without permits. Additionally, interns who are trainees are not counted as official workers.

- Support students and alumni in internships and job opportunities, including becoming self employed

The pilot programme has two distinct types of objectives. The first is related to the skills acquisition of the students, and the second to increase the links with industry to ensure the relevance of the curriculum and to promote experiential learning, leading to greater employability.

As a pilot programme for the AIMS network, it has significant opportunities for scale-up. It enhances the overall offer from AIMS, which traditionally concentrated on academic skills development.

B.1.1 Key statistics: annual budget, success rates, changes over time

The total budget for the cooperative programme over six years amounts to £15,022,972.

Figure 2 Budget allocation for the AIMS cooperative programme

Year	1	2	3	4	5	6
Budget	£716,488	£1,910,901	£2,316,263	£2,615,183	£3,631,711	£3,832,427
Total budget						£15,022,972

The provision for bursaries accounts for 55% of the budget allocated, 34.5% is allocated for salaries and professional fees and the remaining 13.5% is for overheads and expenses. In the first years of the programme the cost for the cooperative student is based on a full year's accommodation (including food), access to extracurricular activities, the cost of health and wellbeing (insurances) and the stipend for the student (including travel). The placement follows on from the 10 months at the centre for the academic programme and the cost is calculated at $1000/month to cover accommodation, meals, local travel, living expenses etc.

B.1.2 Main implementing bodies

AIMS is a 'networked' organisation consisting of the six AIMS centres in Senegal, Ghana, Tanzania, South Africa, Rwanda and Cameroon. The network is governed by an International Board of Directors assisted by an Audit and Finance Committee and an Advisory Academic and Scientific Council. The AIMS management is based at the AIMS Secretariat in Kigali, Rwanda and day-to-day management is undertaken by local centre boards in each country.

In addition, AIMS Chapters have been set up in Canada, Germany and the UK. Chapters drive partnerships, are responsible for resource mobilisation and public engagement activities aimed at supporting the growth of the network. They perform an important function for gaining additional funds and working on the sustainability of the network.

The main funding from the cooperative programme is provided through the MasterCard Foundation. The Foundation works with organisations with the specific goal of increasing access to education and skills. There is a focus on Sub-Saharan Africa. The overall objective of the MasterCard Foundation in relation to this topic is to "contribute to the education of 15,000 young people". This in turn should lead to greater economic growth and social development in the region. The MasterCard Foundation provides $25million to AIMS for the purposes of supporting 500 talented students from socio-economically disadvantaged backgrounds. For the cooperative programme, they are supporting 80 in total over the period of the programme.

B.1.3 Target audience, types of participants, variations among the countries

The pilot is currently only being run in Senegal. The target audience is a yearly cohort of AIMS Master's students. In the first year (2015/16), 12 students were approached to be on the cooperative Master's programme. The students include individuals from Senegal, Cameroon and Rwanda (10 male and 2 female).

In the second year (2016/17), a more formal application process has been implemented and there are 600 applicants for 20 places. As the placements are in Senegal, it is necessary for the students to speak French.

B.2 Mode of implementation

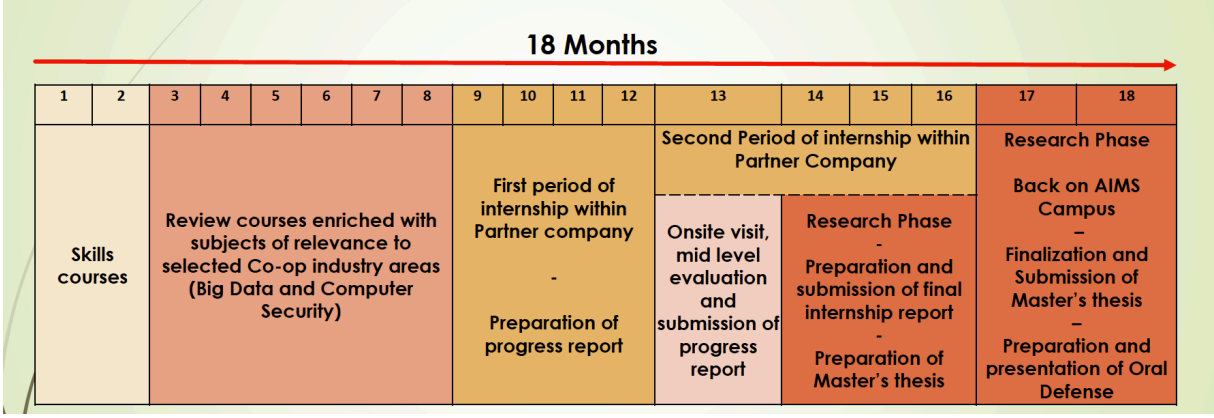
B.2.1 Key characteristics of the projects

The initial idea behind the programme came from observing the cooperative education model in Canada which is a highly successful and recognised mechanism for higher education. The education model works well in subject specific settings and therefore is considered to be a relevant model for mathematical sciences. AIMS has the aspiration to be a member of WACE (World Association of Cooperative Education).

The AIMS Senegal cooperative programme is the first of its kind in the AIMS network. The pilot programme following the same approach as the traditional Master's with 10 months in the AIMS centre. This is supplemented with an additional eight months, of which six months are in a company to gain the hands-on experience of industry. This is followed by a final research phase back at AIMS.

The following graphic shows the timeline and the main components of the pilot.

Figure 3 Cooperative programme timeline



The programme is working with specific industry sectors in its first years – focusing on issues of big data and computer security. These are two areas where it is considered the students can add significant value at mathematicians, thus making it easier for industry to see the benefits of the intern.

Figure 4 Why Big Data and Computer security?

There are now enormous amounts of data being created as a consequence of the way we live and work, from phones, credit cards, computers etc. African industries are catching on to the need to explore big data to help with market intelligence and strategic decision making. This makes industry keen to have specialists in the area.
Computer security or information systems security is the act of protecting intellectual property in an organisation. It is a growing field of employment. In Africa, companies lack the expertise in this field, although there are increasing numbers of higher education institutions training specialists in security auditing, systems security analysis and network security engineering. Having an intern who can help identify the problems a company might face and help to protect them from cyber-attacks for example is a very interesting proposition.

The programme design phase included input from national and regional stakeholders. In addition, a cooperative steering committee has been established to advise and guide AIMS on strategic decision making and recommendations for the programme design and roll out. The steering group includes members from industry as well as from government.

As well as the steering committee, there is a student development and cooperative manager (SDMC) and two cooperative tutors assigned to the programme.

Part of the responsibility of the SDMC is the following:

- Modelling and promoting a culture of work integrated learning
- Supporting cooperative students in their attempts to secure internships
- Monitor and evaluation progress and learning during the cooperative internships for both the student and the employer

The cooperative tutors have the following roles:

- Tutoring the cooperative preparatory courses
- Assisting the cooperative students in preparing for work
- Supporting students during their internships

In the first pilot, twelve students were enrolled (2 females and 10 male students). Two are interning in computer security and 10 in big data.

There are five companies / agencies partnering with the coop programme in AIMS Senegal:

- **ATOS** – a leader in digital services offering the internships in both big data and computer security
- **Wutiko** – a job search platform with hundreds of registered companies, offering internships in both big data and computer security
- **Firefly media** – Advertising service provider offering internships in both big data and computer security
- **Nadji-bi** - Solar Energy provider, offering internships in big data
- **Progede2** - Governmental programme of *Direction des eaux et forêts* in partnership with the World Bank, offering an internship in computer security and statistics (Government)

Most of the companies are also collaborating with AIMS to enhance the experiential learning component of the programme. ATOS has recently sent a member of staff to work alongside the tutors and lecturers to deliver courses in big data. One of the reasons for doing this is to take on board the lessons learnt from industry in the first year of the programme, and input into the course material for the second-year students, improving their relevant skills.

B.2.2 The level of support available

The 18-month programme is fully integrated with the existing AIMS Masters', but also tailored to the needs of the internship. As well as the support provided by the SDMC and the cooperative tutors (as described above), the pilot activities also include:

- Additional seminars
- Entrepreneurship weeks
- Industry visits
- Community service
- The internship opportunities search and placement

The seminars take place on a weekly basis and focus on practical training, post graduate or career related topics. The aim is to enhance the students' understanding of opportunities and the world of work. The entrepreneurship week provides a time for the students to meet with companies and start ups and to find out how to be an entrepreneur and start a business. Industry visits take place throughout the course as a way of connecting the students regularly to the world of work and seeing how mathematical skills and knowledge can be uses to solve industry problems. Community service in the first year of the

programme involved working on a high school competition, mentoring pupils and helping to build science skills and robotics. There was also a "space bus" which came to the AIMS centre and students could volunteer to run workshops and help with the exhibition.

The centre also helps with the set-up of the internship opportunities and making links with companies.

B.2.3 Elements of international collaboration, academia-industry collaboration, curriculum development

In terms of international collaboration, AIMS has set itself the ambition of being a member of WACE (World Association of Cooperative Education). The organisation is already working with them and attending annual meetings. The University of Ottawa has provided advice and guidance on the set up of the programme.

The first five companies for internships are all in Senegal and therefore these are national academic-industry links. The focus on big data analytics and computer security makes the AIMS students attractive interns. The course is more aligned to big data analytics (and this fits better with the technical knowledge of mathematicians), which is why there are fewer placements in computer security.

The relationship between the companies and AIMS is formal and informal. There are regular meetings and visits between the centre and the companies during the placement. As already highlighted, industry is represented on the steering committee. Setting up the relationships in the first place was challenging. However, ATOS and Wutiko were the first to come on board and the others followed based on AIMS having a relationship with these companies.

The curriculum has been developed by AIMS and supported by the University of Ottawa and the industry partners. The industry partners influence the curriculum through their presence on the steering committee, as well as through guest lectures throughout the year. Bringing industry case material into the standard AIMS Master's programme helps better prepare the cooperative students for their internships.

AIMS wish to increase the number of companies involved in the cooperative programme, especially since there will be 20 placements in the second year. The main way of doing this is through referral from the companies involved in the first year.

The steering group also includes policy makers and there are two people who are involved in the Plan Senegal Emergent (including the Vice Chair).[9]

B.2.4 Complementarity / overlaps with other local or regional activities

Full cooperative programmes are not common in Africa. There are no examples which came to mind from the staff at AIMS (although there may be some at the vocational education and training level). Career placements and structured internships are not common in the general university education system as they tend to be costly and time consuming to organise. In general, the responsibility is given to students to find their own placements and they tend to be unpaid.

B.2.5 The main reasons for this mode of implementation and the advantages/disadvantages

As AIMS developed, it became evident that a focus on academic skills acquisition was not enough, as many of the students are attracted to jobs in industry (rather than academia). As a consequence, AIMS invested in an overall industry initiative which includes approaches like the cooperative programme in Senegal.

There were a number of key elements which needed to be addressed for the new industry initiative to work:

[9] http://www.gouv.sn/IMG/pdf/PSE.pdf

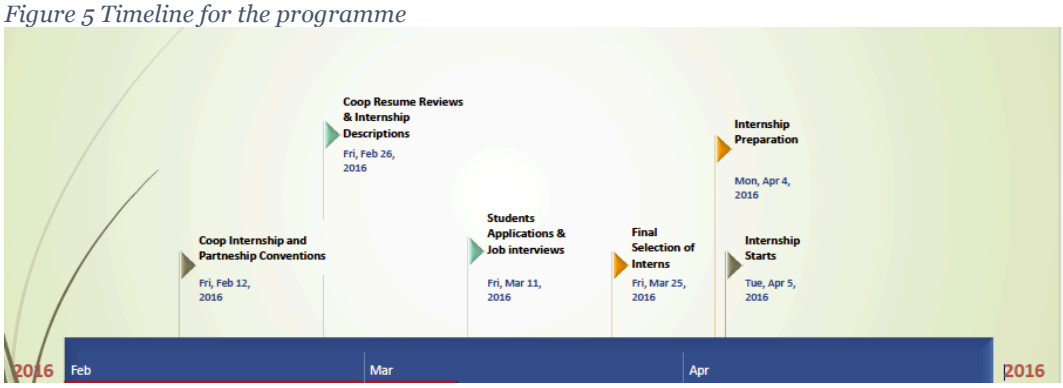
- Additional funding from donors. The main donors for AIMS have been international aid agencies (public). In order to expand to industry activities, it was necessary to acquire additional funds and additional funding streams. DFID was one of the first donors to require an industry focus be added to the objectives of AIMS. This led to the first ideas generated under the "industry initiative" which included adding elements to the curricular to support entrepreneurship. The MasterCard Foundation have also been instrumental in repositioning AIMS to address industry/employment as well as academic objectives
- Fostering links with industry – students need to have companies in which to intern. Significant work has gone into the relationship building with industry. This is not just about the placements, but also the quality, involvement and added value which can be attained through the creation of long lasting links with industrial stakeholders

MasterCard is involved with AIMS through a number of other activities and therefore is an important donor for the organisation. AIMS is currently building on the cooperative model to include a Skills for Employability (SFE) programme which will be available in 10 Francophone countries. Some of the lessons learnt from the curriculum revisions in the cooperative programme will be used to develop the course for the SFE.

B.3 Main achievements, results of the programme

The programme is only now finishing its first year. In the case of ATOS, three of the 5 interns will be considered for full time positions at the end of the programme. ATOS also have a strong commitment to coming into the centre and teaching the students through case material. AIMS is currently putting a baseline monitoring and evaluation system in place and will carefully monitor the students post-AIMS.

Figure 5 Timeline for the programme



B.3.1 Key benefits delivered to the different types of participants

For the industry partners: Access to new skills; influence the curriculum in the long term; lower internal training needs for new graduates; long term collaboration (start of research projects with AIMS students)

For the intern: Industrial exposure; applied mathematics used to answer industrial research problems; opportunity of employment; paid internship

AIMS has the opportunity to further strengthen its relationships with industry, better understand its position as an organisation in Africa which is hoping to address Africa's challenges. AIMS as a research institute also has access to new research problems from industry who can work together with the researchers in joint projects. Before the cooperative programme AIMS Senegal had no industrial links.

B.3.2 Impacts

The inclusion of policy makers in charge of the "Emergent Senegal Plan"[10] means that AIMS has the opportunity to influence policy. The organisation as a whole understands the important of including policy makers in decision making at AIMS and keeps close to government in all of the countries in which it operates. AIMS feels that without the support and backing of government, it would not be possible to build a reputable brand of mathematics education in Africa. Government is also a strong supporter of industry in Senegal and therefore has a vested interest in making sure that appropriate talent is made available.

On research, as AIMS expands its research capacity across the network, it is always looking for ways in which it can impact on societal challenges for Africa. Working closely with industry is important for the model of sustainability of the network. In the long run, it can help AIMS to diversify funding sources and open the way to bring more funds into the centres through collaborative research projects.

B.4 Lessons learnt, changes over time

B.4.1 Key success and enabling factors in the approach identified

The first pilot phase of the programme was very reflective in practice. During the 18 months of implementation there were a number of changes made in order to respond to the realities in the field, taking into account:

1. The initial requirements of the employers
2. The advice from the AIMS cooperative partners
3. Internal feedback (AIMS)
4. Feedback from the students and the employers during the internships
5. MasterCard Foundation transition meetings

This has led to nine important lessons being identified during this learning process which constitute success factors:

Flexibility and adaptability – the cooperative employers have diverse requirements and the students have to settle into these different environments. This means the AIMS team need to be responsive through the process. In addition, with careful feedback, it is possible to adapt the curriculum in real time to deal with some of the market requirements.

Readiness and planning – There needs to be adequate time spent on speciality courses and seminars prior to the internship. Additionally, the employers need preparation to have a relationship with AIMS and the student. The students also need to be prepared to have a relationship with the company and with AIMS throughout the process.

Polite resoluteness – There needs to be firmness in setting out the working conditions of the internships. There also needs to be a common understanding of the needs of AIMS as the academic partner, ensuring the firm gives the access necessary for AIMS to gather evidence for the academic requirements of the internship. Another aspect in this is fulfilling the funder's requirements. The MasterCard Foundation stipulate certain conditions such as entrepreneurship training.

Fairness and neutrality – There needs to be a fair and neutral stance in face of any conflict situation between the employers and the interns.

Importance of time management – Students need to inculcate a sense of good time management, as do the supervisors of the internships. This is something which needs to be embedded throughout the course and made clear through the agreements with the employers.

[10] http://www.finances.gouv.sn/en/Docpdf/PAP_2014-2018_of%20PSE.pdf

Importance of solidarity and proactivity – The students on placement, particularly those who are placed alone need to keep connected during the placements for their own reflective practice and problem sharing. The come together through "give back" events to see what they can then do for society.

Gender sensitivity – One of the wider objectives of AIMS is to promote inclusive access to mathematical sciences. This means that partners working with AIMS also need to respect this and therefore ensuring that employers subscribe to the same values is crucial.

Cultural / language awareness – AIMS students come from across Africa but through their training are expected to work bilingually in French and English. It is important to encourage this from the outset and to help prepare students for studying and working in a multicultural environment.

Comprehensive and experiential learning – Students need to be in a position to set their own professional and personal goals for their internships, albeit in collaboration with the centre and the employers. This needs to constitute an agreement where both sides are able to benefit, but ultimately the students' needs to acquire the skills needed for employability.

B.4.2 Main barriers to overcome, possible solutions

The main barriers have manifested themselves to be:

- Common understanding of the objectives of the placements
- Ensuring students have the broad range of hard and soft skills necessary for a successful work placement
- Dealing with any issues related to a lack of common objectives

Throughout the first phase of the pilot, AIMS has sought advice, feedback and retro-action at every stage. This has led to the above lessons being identified and the following solutions put into action:

- Reinforcement seminars take place right after the first meeting with the employers to focus on the technical skills which are necessary prior to the internship
- Professional development and soft skills / life skills training is now conducted to prepare students for general work place requirements and life outside of the AIMS campus
- There has been a readjustment and time allocation given to conversations between AIMS, the students and employers following the advice of the AIMS partners and the conflicts / special cases that occurred during the acceptance of the internship offers and at the beginning of internships

In addition, from the lessons learnt so far, an action plan has been drafted for the 2016-2018 cohort and will continue to be adapted throughout the life time of the programme.

B.4.3 Monitoring and evaluation practices and key indicators used

At the high level, AIMS reports to many donors and is currently reviewing its monitoring and evaluation practices to provide a coherent overview of all its initiatives. DFID set objectives and indicators, some of which cover industry related activities, and AIMS Senegal also has an extensive performance management framework being developed which covers its whole skills for employability programme.

The programme also has a comprehensive guide for cooperative education programmes which includes evaluation templates for students and employers, covering satisfaction and learning outcomes, among other things.

B.5 Transferability of the scheme

B.5.1 Assessment of the transferability of the approach

This approach to cooperative education is almost fully transferable to any other environment. The specific issues which would need to be dealt with relate in general to the status of employment in companies in different countries and what this means for remuneration. The guidance which is available

from the AIMS centre is comprehensive and could be used by any implementer to help set up such a scheme (for example the manager's guide to cooperative education and the templates for evaluation).

B.5.2 Suggestions, recommendations

AIMS has more direct **focus on students**: the current EEEP only included students as second-order beneficiaries whereas AIMS provided much more direct benefits to students. Inspired by AIMS, the Acedmy could consider providing:

- Student internships
- Career advice and training
- Alumni support (after graduation)

AIMS has been very successful in obtaining **sponsorship** from external sources. In addition, it uses its Chapters to help deliver and develop additional international relations. This may not be directly reproducible in the future EEEP but some elements could be useful:

- Externally sponsored chairs: this has already been achieved at the University of Zimbabwe (sponsored by ZIMPLATS) but further lessons could be learned by looking at the more extensive practice in AIMS
- Industry-sponsored projects

As the Academy's programme expands, it will be important to **monitor results** more carefully, including indicators that trace medium-term outcomes, for example by a regular survey of the destination of graduates. This is something which is being implemented consistently across AIMS.

AIMS has a very active steering group for its cooperative programme.

Figure 6 AIMS skills for employability performance management framework (example indicators)

Expected Results	Indicator (Environmental sustainability and gender equality where possible)
Improved delivery of skills for employment programs that incorporate the environment and satisfy various labour market or entrepreneurship needs for youth, women and men and other vulnerable groups	% of AIMS Co-op graduates hired within 6 months of graduation (disaggregated by sex, country of origin)
	# of AIMS Co-op graduates working in their fields of study
	% of AIMS Co-op graduates working in their fields of study
	% of Co-op placements resulting into employment
	The extent to which issues of environment, gender and inclusion of the vulnerable are incorporated into the delivery of the project as reported by the project stakeholders
Enhanced and sustainable gender informed collaboration between institutions that teach skills for employment and private sector businesses, including women-owned businesses in countries of La Francophonie	The number of new partners involved in AIMS Co-op program (disaggregated by the type of partner and country)
	The number of major joint events organised and implemented together/collaboratively by AIMS and institutions teaching skills for employability
	The perception of AIMS key stakeholders regarding the collaborations collaboration between AIMS and the private sector across La Francophonie Africa
	% of AIMS Co-op Alumni rating the quality of Co-op program as "high" (disaggregated by sex)
	% of employers of AIMS Co-op alumni (interns) rating the quality of the AIMS Co-op program as "high"

Appendix C KEMRI|Wellcome Trust Research Programme (KWTRP)

C.1 Description of the programme

The KEMRI|Wellcome Trust Research Programme (KWTRP) is a platform and health research unit of excellence, hosted within the Kenyan Medical Research Institute (KEMRI) (KEMRI has 12 centres in total). The programme was launched in 1989 with the formation of a partnership between KEMRI, the Wellcome Trust and the University of Oxford. Over the years, the programme has grown from a small group of researchers to a well-established state of the art facility that hosts over 100 research scientists and supports 700 staff working across the region. The Programme has offices in Kenya and Uganda. The Programme initially focused on malaria research but research activities have extended into other areas. The main research themes are:

- Clinical research
- Spatial epidemiology
- Health systems
- Genomics and infectious disease transmission; and
- Vaccines

The mission of KWTRP is to deliver high quality research relevant to global health and to build local capacity for undertaking research. The programme has two mandates:[11]

- Health research: conduct research to the highest international scientific and ethical standards on the major causes of morbidity and mortality in the region to provide the evidence base to improve health
- Capacity building: train an internationally competitive cadre of Kenyan and African research leaders to ensure the long-term development of health research in Africa

C.1.1 Main implementing bodies

The key stakeholders are the Wellcome Trust, the Kenya Medical Research Institute (KEMRI) and the University of Oxford.[12]

- KEMRI is a national body that aims to provide overall leadership and guidance for health research in Kenya. The KEMRI-Wellcome Trust Research Programme is embedded within the KEMRI Centre for Geographic Medicine Research-Coast, one of the KEMRI centres in Kenya
- The main funding body, the Wellcome Trust, is an independent charity funding research to improve human and animal health. It is the UK's largest non-governmental source of funds for biomedical research. It has funded the core activities of the Programme since its inception
- The University of Oxford was an initial partner to the programme and supports a substantial number of both local and international researchers, who work within the Programme, contributing to defining the research capacity building platform for researchers in Africa

KWTRP also works closely with the Open University. KWTRP is an Affiliated Research Centre (ARC) of the Open University (comparable to a campus facility) with authority to wholly supervise students registered with that university[13]. The KWTRP does not have own degree awarding powers but are able to offer doctoral training via the support of the Open University leading to a UK research degree qualification (and via a more economical route).

[11] http://kemri-wellcome.org/about-us/

[12] http://kemri-wellcome.org/about-us/#ChildVerticalTab_13

[13] http://www.open.ac.uk/research/main/research-degrees/affiliate-centres

Partners of the KWTRP also include the Kilifi County Government, Department of Health, which provides overall leadership in health service delivery, and facilitates a cordial co-existence with the research centre. Medical staff from the county and periphery health facilities participate in research activities, including clinical research. The Nairobi programme works closely with the Nairobi City County health department and various health institutions with a focus on improving health care systems. Also in Nairobi, several researchers act as technical advisers to Kenyan Government departments. Some of the research work, i.e. a series of clinical trials focusing on in-patient hospital care, have resulted in collaborations with hospitals. For example, the Mbale Clinical Research Unit was launched on the Mbale District Hospital site and includes a collaboration with Busitema University. The Kilifi hub was initially established beside the Kilifi county hospital.

C.1.2 Target audience, types of participants, variations among the countries

KWTRP, amongst others, reaches out to current and future researchers working in the field of health that can apply for funding for research and scholarships.

C.2 Mode of implementation

C.2.1 Key characteristics of the projects

Health research is a core component of KWTRP. To support the research KWTRP has access to various parts of a core platform:

- Key platforms of clinical services
- Community engagement, sampling cohorts
- Laboratories. There are various laboratories and equipment that are part of the various KEMRI centres. Previous research grants (including support from the Wellcome Trust) have allowed for the purchase of the laboratories and equipment.
- Kilifi Health Demographic Surveillance System (DSS), which surveys/census every three months a defined population of 300,000 to provide reliable data for health research and monitoring activities. This census contains historical medical data.

Capacity building activities under the KWTRP are funded under a Wellcome Trust capacity building fund, to which programmes other than KWTRP can also apply. From 2016, this capacity funding at KWTRP[14] is administered via the Initiative to Develop African Research Leaders (IDeAL). IDeAL is a 5-year £8 million, high-quality training programme designed to develop outstanding young African scientists into world-class research leaders.[15] It is based at the KEMRI and will be available to young researchers, from intern to postdoctoral level, with the aim of keeping scientists at African institutions through a defined programme of recruitment, supervision, mentorship, multidisciplinary approaches and clear career paths.

As outlined in the table below, capacity building activities include the School Leavers Attachment Scheme, Undergraduate attachments, and a Postgraduate Diploma. These schemes are implemented with the objective to attract and recruit new potential researchers. Under the School Leavers Attachment Scheme (SLAS) students are offered 2-3 month long attachments to learn and experience the different types of careers associated with research. The Postgraduate Diploma in Health Research Methods is a collaboration between KWTRP and Pwani University. The Programme supports the transition to a research career or further postgraduate training. Training cost and tuition fees are covered by the KWTRP. Students also receive a stipend towards accommodation and other living expenses. The programme plans to recruit 25 students every year, based at both KWTRP sites in Kilifi and Nairobi.

There is also a Master's studentship scheme for students that are already enrolled in master programmes. They are offered the option to do their project as part of KWTRP. Around 10 students

[14] https://wellcome.ac.uk/what-we-do/directories/developing-excellence-leadership-training-and-science-initiative

[15] ibid

receive funding for the research projects per year. The Master's students, whilst registered at local universities, complete the research project component of their training. The studentships, which are funded through the Initiative to Develop African Research Leaders, (IDeAL), provides the students with stipend and an opportunity to spend up to eight month at the Kilifi or Nairobi facilities doing their research projects in a highly productive research environment. Research costs for the project are catered for under the supervisor's research funding.

PhD training is recognised as the foundation for a successful research career. The Programme has developed a quality-assured supervision system that includes a team of two or three senior researchers, and student advisory committee that monitors the students' progress and advises on academic, career and social issues. In addition, the students' progress is monitored through six monthly reports and an upgrading mini viva at the end of the first year to determine their suitability to continue with PhD training. Additional support for PhDs may also come from other grants and collaborative initiatives. PhD graduates are also offered a one-year transition support to help them acquire post-doctorate research positions and continue their careers.

The KWTRP offers retraining of post-doctoral students as part of capacity building and research leadership development. A career path has been defined, beginning from early postdocs through mid and senior research fellows, to principal research fellows. For example, postdocs are supported and mentored to help them develop competitive grant proposals.

Table 1 Capacity building initiatives

Scheme	Duration	Number of students involved per year
School Leavers Attachment Scheme (SLAS)	2 months	8
Undergraduate attachments	2 months	16
Postgraduate Diploma internships / diploma in research methods[16]	8 months	25
Master's studentships[17]	-	10
PhDs	3 years	8
Transition support for PhDs[18]	1 year	8

C.2.2 Key statistics: annual budget, success rates, changes over time

The core activities of the KEMRI are co-funded by the Wellcome Trust on the basis of five year terms of block funding, providing a relatively sustainable stream of funding over time. The block funding is £40m for the five-year period. Every five years KWRTP has to re-apply for the co-funding and undergoes a rigorous review of scientific performance. This includes funding for the core platform:

- Research
- Administrative support
- Support of the key platforms of clinical services
- Community engagement
- Laboratories
- Kilifi Health Demographic Surveillance system

[16] http://careers.kemri-wellcome.org/internships

[17] http://careers.kemri-wellcome.org/content/masters-studentships

[18] http://careers.kemri-wellcome.org/postdoctoral-training

The funding from the Wellcome Trust has, over time, ensured the continuation of the research work undertaken by the Programme. The Wellcome Trust is also providing £8 million for a period of five years (2015-2020) for capacity building via the programme IDeAL.[19]

C.2.3 The level of support available

The KWTRP has three key cornerstone initiatives that contribute to build training and capacity. This involves (1.) outreach activities to recruit future researchers, (2) training PhDs and re-training postdoctoral students and (3) community involvement.

Table 2 Overview of different levels of support of the KWTRP

Initiatives / key cornerstones	Description	Direct beneficiaries
1.Promote scientific leadership	To ensure sustainable development of research, the partnership supports the development of scientific leadership through various initiatives. It seeks to promote science and research through engagement with schools, and has a structured internship programme for introducing Kenyan graduates to research training master's degree and PhD students. Moreover, junior researchers' career path development is supported via partnering with other research institutions in the region.	Schools, graduates and master's students, junior researchers
2. Build research capacity	KWTRP is a multidisciplinary Programme that focuses on health issues (e.g. malaria, pneumonia, meningitis, HIV and malnutrition) pertinent to Kenya and many other African countries. The KWTRP employs around 800 people.	PhD students and researchers
3. Increase community involvement	Community involvement aims at developing a greater understanding of research in the local community. There is a formal strategy for community engagement, supported by experts in policy, ethics and communication.[20] Via community involvement, e.g., the Schools Engagement Programme and social media, the results of research contribute to improving health. The Programme also interacts with secondary school via an online platform.	Opinion leaders, a network of communities and their representatives, secondary schools

C.2.4 Elements of international collaboration, academia-industry collaboration, curriculum development

KWTRP has several partnerships with UK universities and some other European universities, including the University of Oxford (the initial partner), University of Warwick, the Liverpool School of Tropical Medicine, London School of Hygiene and Tropical Medicine, Imperial College, the Open University, and the Institute of Child Health in London. These partnerships involve the following:

- PhD students at KWTRP, once graduating, receive a degree from the Open University
- PhD students at KWTRP take part in a 3-month visiting fellowship in a foreign university (as part of IDeAL)
- PhD students at KWTRP have supervisors from a university abroad (in addition to the local 'programme' supervisor that functions as the primary contact person)
- Some researchers at KWTRP have dual affiliations and may be part-time employed at a foreign university

[19] https://wellcome.ac.uk/what-we-do/directories/developing-excellence-leadership-training-and-science-initiative

[20] Wellcome Trust (2015). Evaluating public engagement in the Wellcome Trust's UK Centres

C.2.5 Complementarity / overlaps with other local or regional activities

IDeAL is one of the funding streams of the Wellcome Trust and the Department for International Development, and is part of the Developing Excellence in Leadership, Training and Science Initiative (DELTAS).

The DELTAS Africa programmes contributed to establishing world-class research environments in African universities, with a strong focus on creating training opportunities for the next generation of researchers.[21] It is a long-term funding strategy. In total, the DELTAS Africa scheme awards over £46 million over a period of five years. The programmes are led by universities and research institutes in Ghana, Kenya, Mali, South Africa, Uganda and Zimbabwe. All the programmes involve collaboration across the continent, including between French-speaking and English-speaking countries, and with international research centres. DELTAS Africa seeks to:[22]

- Produce world-class scientific research to address African health and research priorities
- Support the training of scientists and help them develop their careers
- Nurture mentorship, leadership and equitable collaboration in science, and engagement with public and policy stakeholders
- Cultivate professional environments to manage and support scientific research

The management of DELTAS is being handed over to AESA (Alliance for Accelerating Excellence in Science in Africa), a new research initiative in Africa. As part of the handover mission, project managers are being trained in grants management and are provided with finance training.[23]

Figure 7 DELTAS Africa funded programmes

Source: http://aasciences.ac.ke/aesa/en/programmes/deltas/

[21] https://wellcome.ac.uk/press-release/leading-african-scientists-drive-continents-research-agenda

[22] http://aasciences.ac.ke/aesa/en/programmes/deltas/

[23] ibid

C.3 Main achievements, results of the programme

C.3.1 Results, achievements of the programme

The results with respect to the three cornerstones are the following:

- Research. Currently KWTRP employs around 800 people. KWTRP has around 150 research projects that are currently ongoing, some are funded by the Wellcome Trust and others are funded by other funding bodies
- Capacity building. IDeAL builds on a previous Wellcome Trust Strategic Award[24], which has attracted and trained more than 200 people since 2008. Although only partially attributable to this programme, more than 50 of the beneficiaries are now postdoctoral researchers, 32 are PhD students and more than 50 are research officers in various organisations across Africa. Moreover, the award has led to more than 250 publications, with significant impact on scientific knowledge and health policies in Kenya and globally
- Community involvement. A number of community representatives were consulted about the work of KEMRI, and therefore are closely related to KWTRP. The results are described in the table below
- Sustainable development of research

Table 3 Community representatives consulted about KEMRI's work

Type of change described	Summary of changes
• Build trust and mutual understanding with communities via the community representatives. • Quality of engagement process with representatives. • Community representatives' perception of their role and influence. • Community representatives' ability to give and independent perspective on KEMRI. • Able to address rumours about KEMRI research.	• Community understands KEMRI research, is able to express an independent perspective on it and trusts that KEMRI will address any concerns raised. • Community advisory boards are an effective and trusted mechanism for genuine dialogue about research between the community and researchers. • Negative rumours about the research are challenged within community discourse

Source: https://wellcome.ac.uk/sites/default/files/wtp052364_0.pdf

C.3.2 Key benefits delivered

Ultimately, as a result of the investment in research and related community services, KWTRP has a positive effect on better health and treatment, patients getting the correct treatment and saving lives.

C.4 Lessons learnt, changes over time

The KWTRP research component has developed/grown organically over time. It started as a programme that involved five people and, from the start, was informed by the health issues of the country as well as by developments in the discipline. The design of KWTRP is informed by the big health challenges in Africa and a reflection on the research capacity deficits.

The KWTRP capacity building component was developed at a later point in time and initially involved only piecemeal support (under the Wellcome Trust Strategic Award). Only recently, via IDeAL, the capacity building components of KWTRP took the shape of a more formal strategic programme. According to the director of IDeAL, it is important to first have in place a strong research platform before offering training and capacity building.

[24] https://wellcome.ac.uk/what-we-do/directories/developing-excellence-leadership-training-and-science-initiative

C.5 Transferability of the scheme

C.5.1 Assessment of the transferability of the approach

The KWTRP programme seeks to build capacity by supporting the full career path that is needed to generate research leaders. There may be an option for EEEP to extent the focus on teacher training/research for further career development.

C.5.2 Suggestions, recommendations

One of the recommendations, based on the experience of KWTRP, is to develop a clear strategy, e.g. of where the EEEP wants to be in the next few years. It is recommended that the strategy should emphasise the importance of quality (rather than quantity).

Moreover, it is recommended that the focus of the EEEP should be on building a network of willing engineering departments. This could potentially involve:

- Building top quality at a core of 3-5 engineering departments that can attract postgraduate researchers as well as take ownership for the network, organise a wider community around the network and apply for funding from additional funding agencies
- Competition, following an open call, amongst engineering departments to be a core member of the network, to select the best departments and to ensure a sense of ownership
- The creation of a structure that can run the network with sufficient capacity
- A sizable amount of funding to ensure that there is potential for impact – for example a grant of £500,000 will have limited impact on capacity building

Appendix D Partnership for Skills in Applied Sciences, Engineering and Technology (PASET)

D.1 Description of the programme

The Partnership for Skills in Applied Sciences, Engineering and Technology (PASET) was launched in 2013 by African governments with support from the World Bank. The objective of PASET is to address systemic gaps in skills and knowledge in the fields of applied sciences, engineering and technology. There is a focus on the skills that are thought essential for about 10 sectors that drive Africa's structural transformation: including agriculture, mining, manufacturing, electrical power, infrastructure and construction, ICT, health and financial services, among others. Moreover, the objective is to "build the capacity of African education and training institutions to train high quality technicians, engineers and scientists to meet the demands of the economy".[25] Specific objectives are outlined below:[26]

- Support Sub-Saharan African (SSA) countries to build a skilled labour force by focusing on the continuum of skills, from foundation skills to upper secondary/technical/vocational training, as well as higher education, scientific research and innovation
- Target skills in Applied Science, Engineering and Technology for specific priority sectors to complement and maximise returns from domestic and foreign investment in these sectors
- Promote strategic partnerships between governments, business and partner countries from other regions to invest in skills in ASET in SSA

[25] World Bank. 2016. The partnership for skills in applied sciences, engineering, and technology (PASET). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/405111468197982834/The-partnership-for-skills-in-applied-sciences-engineering-and-technology-PASET

[26] http://www.worldbank.org/en/programs/paset#2

- Strengthen mechanisms which promote regional institutional collaboration and in specific programs and areas within ASET
- Strengthen ASET systems and institutions in Africa, including through improved policies, systems, standards and mechanisms to assure quality and relevance; to monitor progress and to ensure focus on results
- Enable the systematic sharing of knowledge and experience among SSA countries, and between SSA countries and Partner countries in building ASET capacity to promote development

PASET acts as a convening platform to facilitate increased coordination and resources via collaboration between public and private sectors. The partnership comprises Sub-Saharan African governments, Higher Education Institutions (HEIs) and Vocational Education and Training institutions in Sub-Saharan Africa that have a focus on 'ASET' disciplines, academics; Africa regional bodies; and partner countries from other regions.[27] In June 2016, 21 African countries and representatives of Brazil, China, India, and Korea have participated in the activities organised under the umbrella of PASET.

D.1.1 Main implementing bodies

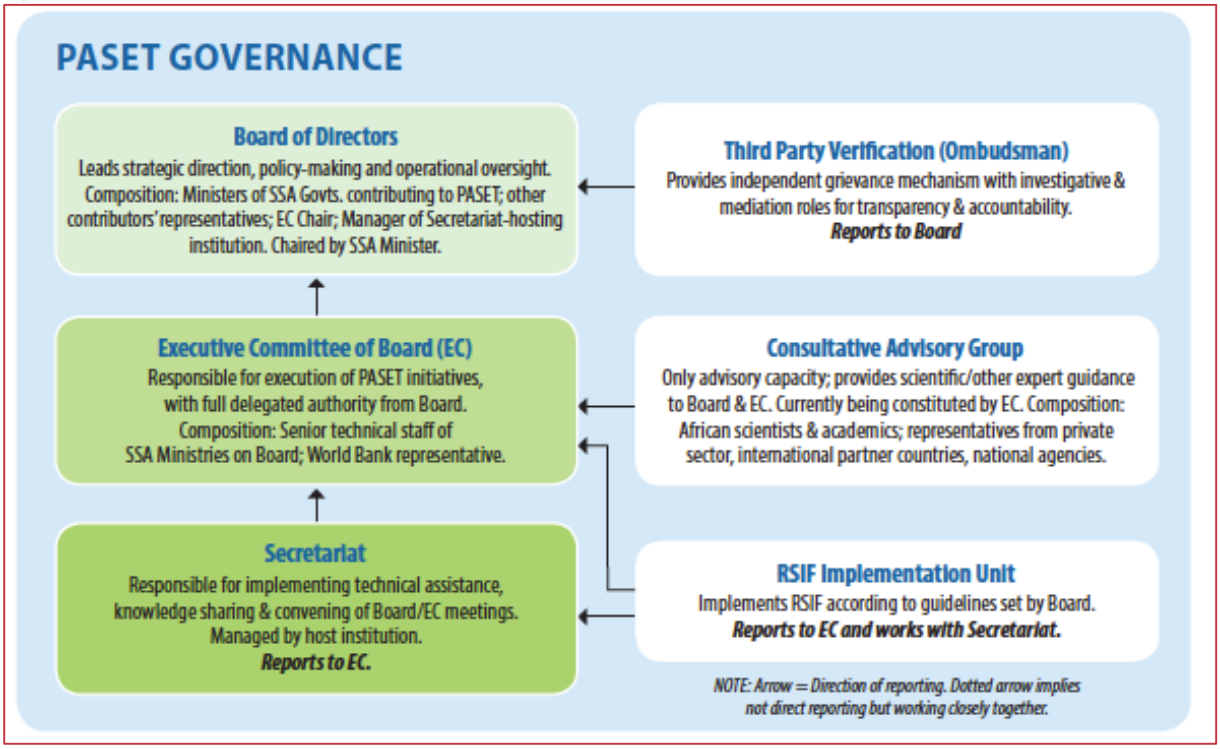
The success of PASET is linked to its solid ownership by African governments, private sector, and regional organisations.[28] The institutional framework of PASET includes a Steering Committee, a Technical Executive Committee, a Consultative Advisory Group, and a Secretariat.[29]

The partnership is organised as follows:

- The Board of Directors of PASET sets strategy and approves key actions. It is led by education/higher education ministers of PASET's founding countries (Ethiopia, Rwanda and Senegal), World Bank representatives and the Chair of the PASET Consultative Advisory Group (as observer)
- The Executive Committee of the Board implements the decisions taken by the Steering Committee and consists of SC's alternate representatives from governments of Ethiopia, Rwanda and Senegal, and the World Bank
- The Consultative Advisory Group of PASET is set up with the objective to provide technical advice and broader links to the scientific academic, and business communities and is made up of scientists, academics and business leaders from within Africa
- The Secretariat of PASET serves as the administrative arm of the Partnership. While the (interim) Secretariat is currently housed within the World Bank, it is planned to be transferred to an Africa-based institution in the next few years. The World Bank plays a facilitating role to bring together partners, African government, private sectors, etc. For instance, to support the realisation of an initiatives, the World Bank develops a document outlining the best practices of running a scholarship programme (e.g. eligibility criteria). This document is shared with the Consultative Advisory Group which in return provides technical advice. Thereafter, the document is shared with the Technical Executive Committee who can decide to accept the guidelines. The World Bank also facilitates the organisation of meetings between the different partners and hires consultants to provide input.

[27] ibid
[28] ibid
[29] ibid

Figure 8 Governance structure



Source: The Partnership for Skills in Applied Sciences, Engineering and Technology (PASET), October 2016

The activities organised by PASET are supported by SSA governments, the private sector, new partner countries, and development partners. Partners can sponsor/fund regional activities and provide funding for the Regional Scholarship and Innovation Fund (RSIF): (i) PhD training (ii) Research Grants and (iii) Innovation Grants.[30]

Other activities coordinated by PASET include:

- Technical assistance/funding of the Regional Technical and Vocational Education and Training (TVET) Centres for Excellence
- Building capacity in Africa for the Regional Benchmarking Initiative for Universities
- Participation in advisory committees and technical committees

Partners can also support PASET and provide technical assistance, internships and work experience for students graduating from ASET institutions, see section D.2.4 .

D.1.2 Target audience, types of participants, variations among the countries

PASET is a partnership that is mainly targeted at Sub-Saharan African countries. For the first phase of the programme, the World Bank focused on creating a partnership between nine selected countries: Ethiopia, Guinea, Liberia, Mozambique, Nigeria, Rwanda, Senegal, Sudan and Tanzania.[31] Beneficiaries from PASET include:[32]

[30] World Bank. 2016. The partnership for skills in applied sciences, engineering, and technology (PASET). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/405111468197982834/The-partnership-for-skills-in-applied-sciences-engineering-and-technology-PASET

[31] http://www.universityworldnews.com/article.php?story=20130718162040419

[32] ibid

- Sub-Saharan African governments, particularly their ministries of higher education or science and technology are the prime movers of the initiative.
- The private sector in SSA
- ASET-focused universities
- TVET institutions
- SSA university faculty and students interested in PhDs in ASET fields
- The PASET partner countries - Korea, China, Brazil and India – as well as Norway

D.2 Mode of implementation

D.2.1 Key characteristics of the projects

Each of PASET's initiatives addresses a specific aspect of the ASET skills shortage in Africa. Initiatives planned for the first phase include[33] the Regional Scholarship and Innovation Fund (RSIF), Regional Benchmarking Initiative for Universities, and forums, learning events, workshops and exchange visits.

The RSIF is a so-called PASET flagship initiative, implemented by the Association of African Universities (AAU), guided by the PASET Secretariat and Executive Committee of the Board, and benefiting from technical assistance delivered by experts/consultants. This fund is intended to "provide PhD training to create a highly skilled ASET workforce in both academia and industry, as well as build capacity of selected universities to deliver high quality PhD programs in selected thematic areas in partnership with high-ranking global universities".[9]

The aim is to launch a call to select its participating SSA universities in late 2016, and to launch the scholarship in the Autumn of 2017. RSIF will also facilitate scholarship recipients to undertake applied research to support priority development sectors, and in innovating for businesses or establishing new enterprises. Although the RSIF is currently operational, it is working on the following:[34]

- Establishing eligibility rules, selection criteria, and processes for students and universities
- Designing the organisational structure and procedures to ensure efficiency and transparency in accordance with global best practices in scholarship program management
- Laying out clear processes for funds disbursement and utilisation

The Regional Benchmarking Initiative for Universities[35] was launched in 2015 and aims to drive a cultural paradigm of data-driven strategic planning in higher education institutions in Sub-Saharan Africa. More specifically, it aims to improve the quality and relevance of higher education by equipping ASET focused institutions with the capacity to identify their strengths and weaknesses, and assess and monitor their progress relative to similar national, regional and global institutions. It was argued that improving the ability of HEIs to measure their institutions' performance in science, engineering and technology education is a priority.[36] It is thought that (the voluntary) benchmarking would contribute to strengthening the quality of scientific research and knowledge transfer.[37]

[33] ibid

[34] The PASET Regional Scholarship and Innovation Fund, World Bank.

[35] The PASET Regional Benchmarking Initiative to Strengthen African Universities. http://documents.worldbank.org/curated/en/215061468181132396/pdf/105382-BRI-PUBLIC-Benchmarking-factsheet-2016.pdf

[36] http://blogs.worldbank.org/nasikiliza/benchmarking-to-boost-africas-science-and-technology-education-standards

[37] ibid

The Shanghai Jiao Tong University of China is providing technical assistance. The main objectives are to:[38]

- Enrol and train participating African institutions in effectively using the results of benchmarking to assess and improve their performance
- Partner with leaders in interested universities, national tertiary education agencies and sub-regional organisations, and support them to build capacity to regularly guide benchmarking in institutions under their purview
- Create the capacity within an interested African institution (university, Pan-African institution or national tertiary education agency), to lead and support future benchmarking exercises and related training and technical assistance at the regional level

A range of initial steps are currently being implemented. First, African universities are being enrolled to participate. Currently about 48 public and private African universities from 14 countries across the region are involved and have contributed to the testing of the preliminary benchmarking methodology that has been developed.[39] The initiative will be opened to a larger group of universities after this testing phase.

Second, based on a call for proposals, an African institution will be selected to serve as a Regional Centre for Data on African Universities. Training for the hub will be delivered by experts from the World Bank in collaboration with the Shanghai Jiao Tong University's Centre for World Class Universities. The hub will be used to:[40]

- Collect, store and analyse relevant data from national agencies, as well as the universities themselves
- Carry out benchmarking on a regular basis and regularly update its methodology, student surveys and industry surveys
- Provide technical assistance on benchmarking to the institutions, national higher education agencies, and regional/sub-regional organisations
- Publish studies and data-based reports on a regular basis

Third, to develop partnerships, the donor community and interested private sector groups are being targeted to engage in knowledge-sharing activities, provide financial and other in-kind assistance to support the initiative. Finally, a series of regional and national training workshops are organised – on the topic of benchmarking – for interested government departments and higher education institutions.

First phase initiatives also provided space for the organisation of forums, learning events, other workshops, and exchange visits to further promote PASET with governments, the private sector and institutions. Exchange visits have been organised with Korea to facilitate collaboration.[41]

Fourthly, current initiatives include the Country Specific Action Plans (CAAP).[42] These are envisaged as country-level plans that detail strategies for developing ASET skills from upper secondary/TVET levels through higher education. These plans will be used to help mobilise funding from the government, multi-lateral agencies, new partners and the private sector.

[38] The PASET Regional Benchmarking Initiative to Strengthen African Universities. http://documents.worldbank.org/curated/en/215061468181132396/pdf/105382-BRI-PUBLIC-Benchmarking-factsheet-2016.pdf

[39] ibid

[40] ibid

[41] World Bank. 2016. The partnership for skills in applied sciences, engineering, and technology (PASET). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/405111468197982834/The-partnership-for-skills-in-applied-sciences-engineering-and-technology-PASET

[42] The Partnership for Skills in Applied Sciences, Engineering and Technology (PASET), October 2016

Second Phase Initiatives will include:[43]

- Regional TVET Centres for Excellence focused on technical and vocational education and training. The idea is to model these centres on the World Bank financed Africa Centres of Excellence (ACE) project for higher education
- Data Initiative will build capacity for regular data collection and analysis needed to inform policy decisions and public dialogue in Africa
- Regional quality assurance framework for post-graduates – to ensure a commitment to quality and excellence in post-graduate programmes

D.2.2 Key statistics: annual budget, success rates, changes over time

PASET is building two funds: Regional Scholarship and Innovation Fund (RSIF) and a trust fund that is used to support various other initiatives such as the Regional Benchmarking Initiative.

The RSIF builds on a $2m financial commitment from each of the following countries: Senegal, Rwanda Ethiopia, Kenya and Cote d'Ivoire ($8m in total). PASET is currently seeking support from other financial partners and a number of other countries have shown interest in the RSIF. The target is a fund of $100m and additional technical and capacity building support (e.g. support with needs assessments and internship or mentoring opportunities). PASET is also looking to acquire financial support from the private sector for the RSIF. The World Bank does not provide funding for the RSIF. So far no PhD students have been in the RSIF, although the ten-year goal is to enrol 10,000 students, dependent on the availability of funding. The first cohort of students will start in the Autumn 2017. PASET is still reviewing the cost per PhD student in terms of affordability and competitiveness. The aim is the make the scholarship competitive and attractive.

PASET is currently building a trust fund, which is currently managed by the World Bank. The World Bank, as the current secretariat of PASET, applies for funding from this trust fund to financially support the Regional Benchmarking Initiative, the launch of TVET centres of excellence and/or knowledge sharing activities. Countries that have donated to the trust fund are Norway and the partner countries China and Korea. Korea is on the advisory group and also provides technical advice on the initiatives. The budget for the Regional Benchmarking Initiative covers the expenses of experts and consultants, preparation of documentation, catering, and some support to the host of the benchmarking initiative in Africa. The next stage is expected to result in some additional costs because it will involve the development of an online system for data collection, the display of results, and the selection of the institution to host and organise the event (the first PASET Regional Benchmarking Capacity Building Workshop was help in Nigeria but the World Bank Education Team (Africa region) helped organise the event). The projected costs in relation to the Regional Benchmarking Initiative will be around $150-$250k per year, excluding Travel and Subsistence (T&S) costs for workshop participants. Workshop participants have, up to date, covered their own T&S costs.

The World Bank has provided some additional financial support for these activities (i.e. the Regional Benchmarking Initiative, the launch of TVET centres of excellence and/or knowledge sharing activities) separate from the trust fund.

D.2.3 The level of support available

PASET is led by African governments, who are the final decision makers of the programme and are motivated to improve national capacity. In the interim (the next 2-5 years), the World Bank will provide technical support – see table below - and only some financial support. The World Bank, for example, has paid for some of the travel costs in relation to meetings for the creation of PASET.

[43] ibid

Table 4 Interim role of the World Bank in support of PASET initiatives

Initiatives	Role of the World Bank	Direct beneficiaries
Regional Scholarship and Innovation Fund (RSIF)	Support capacity building via the provision of a supportive eco-system	PhD students
Regional Benchmarking Initiative for Universities	Support networking, capacity building, knowledge sharing	Various stakeholders
Knowledge-sharing activities	Support networking, capacity building, knowledge sharing	Various stakeholders
Country Specific Action Plans (CAAP)	Support development of national strategy. Help mobilise funding	National governments, ministries and other national bodies

D.2.4 Elements of international collaboration, academia-industry collaboration, curriculum development

At the regional level, the capacity building workshops and benchmarking initiatives are core to regional-international cooperation and the sharing best practices across the African continent.

Rather unique to PASET is the engagement with the partner countries e.g. China, South Korea, Japan, India and Brazil. These PASET partner countries have made substantial capital / infrastructure investment in the region and would benefit, in the longer-term, from supporting education and skills training in the region to help operate and maintain these infrastructures.[44] Previous engagements may not have been focused, or adequately targeted, towards the African countries' human resources development plans.[45] PASET aims to expand knowledge-sharing between the region and partner countries.[46] The partner countries are contributing to PASET via the following initiatives:

- Korea has showcased how they are organising benchmarking activities, what they have done well and what African countries could learn from the Korean experience
- A number of universities from Korea are to be involved in the Regional Scholarship and Innovation Fund (RSIF). Some universities are involved in a sandwich programme, a curricula development programme and faculty training programme that can help boost the quality of the PASET Scholarship Programme
- Brazil was involved in previous exchange visits on Technical education and training (TVET) and a number of delegates from African countries visited Brazil
- Building on the foundations of the World Bank African Centres of Excellence (ACE) Programme and previous collaborations with India, it is expected that, as part of PASET, there is space for future research collaboration with India
- China and Korea have given financial support via the PASET trust fund

Norway has also provided financial support to the Regional Scholarship and Innovation Fund (RSIF).

D.2.5 Complementarity / overlaps with other local or regional activities

PASET is finding its own niche and avoids duplicating what some other programmes are doing. For example, the scholarship programme would allow students to stay in Africa (rather than go abroad) and would allow them to receive a degree from an African University.

[44] http://www.universityworldnews.com/article.php?story=20130718162040419

[45] ibid

[46] World Bank. 2016. The partnership for skills in applied sciences, engineering, and technology (PASET). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/405111468197982834/The-partnership-for-skills-in-applied-sciences-engineering-and-technology-PASET

There are a number of national initiatives around building national education capacity. As part of the benchmarking initiative, PASET works with the national agencies and ministries involved to see how PASET/the World Bank can support and bring added value – and avoid displacing already existing initiatives. For example, in Rwanda, the Higher Education Council wanted to host their own benchmarking workshop. The World Bank provided support to this initiative by bringing in an expert to this workshop, but did not organise a separate workshop that would be of interest to the same stakeholders.

PASET supports the development of the country ASET action plan in participating countries - i.e. it helps countries develop a plan to develop capacity within their countries. The World Bank is developing a number of tools to assist countries to develop their own plan.

D.2.6 The main reasons for this mode of implementation and the advantages/disadvantages

PASET originated out of an international forum held in 2014. The forum asked a number of critical questions, i.e. what was being done to build capacity in priority areas across the African continent and what can be done differently. Priority was given for a programme that would be owned by national and regional stakeholders, and would benefit from (only) interim management from the World Bank, with space for sharing international best-practices.

PASET also builds on previous work on the African Centres of Excellence (ACE)[47] 2014, which among other objectives sought to "promote regional specialisation among participating universities in areas that address specific common regional development challenges", including STEM fields. In this initial phase, PASET has involved some of the universities that had been competitively selected to be part of ACE.

D.3 Main achievements, results of the programme

D.3.1 Results, achievements of the programme

The programme is currently in the process of launching its initiatives. With regards to the Regional Scholarship and Innovation Fund (RSIF), the first cohort of PhD students is expected to be enrolled in the Autumn of 2017 (so far there have been no enrolments). It is expected that in the first year there will be 100 PhD students enrolled, which would allow the HEIs involved to slowly build capacity.

There have already been some initial outcomes from the Regional Benchmarking Initiative. A first regional benchmarking capacity building workshop was held in June, 2016 in Nigeria. This workshop was organised by the World Bank Education team for Sub-Saharan Africa (SSA), under the umbrella of PASET and in collaboration with the Association of African Universities (AAU) and Nigeria's National Universities Commission (NUC). The objective of the workshop was to analyse, discuss and disseminate the results of the pilot benchmarking exercise. A second objective was to encourage further participation by industry and partner countries. The workshop provided space for knowledge sharing with partner countries and interaction with industry - a set of recommendations were put forward - and to plan for benchmarking capacity building in the region for the next 2-3 years. There is an agreement amongst participating institutions on some of the key benchmarking indicators used to monitor their learning outcomes for example:[48]

- Proportion of graduates who get employed within six months of graduation
- Proportion of graduates who obtain professional registration within two years of graduation
- Proportion of graduates who start their own firms/are self-employed within two years of graduation

[47] http://www.aau.org/content/africa-centres-excellence-project-ace

[48] http://blogs.worldbank.org/nasikiliza/benchmarking-to-boost-africas-science-and-technology-education-standards

Another set of benchmarking indicators that has been agreed upon includes indicators that assess policy and facilities to accommodate students with physical disabilities and low income backgrounds, and indicators that capture institutional relevance, internationalisation, research results and governance.

Furthermore, as part of this initiative, it was agreed that the way forward would be for participant countries to obtain support for the Programme from e.g. ministries of finance and economic development and the private sector.[49]

D.3.2 Key benefits delivered to the different types of participants

Due to the recent start of the Programme it is only possible to outline the expected benefits of PASET. Key expected benefits/initial benefits to the different participants include the following:

- Sub-Saharan African governments, particularly their ministries of higher education or science and technology will benefit from collaborating at a regional level. They will also acquire valuable information and technical assistance to inform their policies and develop costed, results-oriented plans (CAAP) to help align their programs, monitor results, and leverage more funding
- The private sector in SSA will gain a stream of home-grown, highly skilled graduates (from the TVET level to researchers) for employment and internships
- ASET-focused Universities will be able to: (i) Improve the quality of their faculty, academic programmes and research; (ii) Build stronger international ties with "sandwich" universities outside Africa who will serve as hosts to RSIF scholars; and (iii) Better assess their performance by participating in programmes like the Regional Benchmarking Initiative
- TVET institutions are expected to improve their academic programmes and their faculties' professional and pedagogical skills. They will also benefit from the proposed TVET Centres of Excellence, which will provide faculty training, quality assurance and curriculum development
- SSA university faculty and students interested in PhDs in ASET fields will be able to apply for funding through the RSIF, which will support their PhD training and research and subsequently, new enterprise development

The PASET partner countries - Korea, China, Brazil and India - benefit from the programme in relation to their bilateral development and investment agendas for Africa. These partner countries –are investing in Africa, and 'it would be to their and Africa's advantage to develop the necessary human resources to operate and maintain the infrastructure being built so as to maximise the return on their investments'.[50]

PASET also aims to provide opportunity to scale-up existing bilateral development initiatives to support TVET or science and technology.

D.3.3 Impacts

There are two main indicatives that are core to the education agenda. First, the Regional Scholarship and Innovation Fund (RSIF), which by means of the provision of scholarships for PhD training and funding for research supports the development of a sustainable system and through the creation of and international supportive community, provides researchers with a more supportive eco-system. The second main initiative is the Regional Benchmarking Initiative for Universities that provides a basis for universities to evaluate their own outputs. The data stemming from this initiative is intended to inform evidence based policy making.

The PASET outlined a set of ten-year (medium-term) goals:[51]

[49] http://www.universityworldnews.com/article.php?story=20130718162040419

[50] ibid

[51] World Bank. 2016. The partnership for skills in applied sciences, engineering, and technology (PASET). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/405111468197982834/The-partnership-for-skills-in-applied-sciences-engineering-and-technology-PASET.
& The Partnership for Skills in Applied Sciences, Engineering and Technology (PASET), October 2016

- Support training of at least 10,000 new PhD holders in ASET fields in Sub-Saharan Africa
- Establish an SSA- wide regional post-graduate scholarship programme in ASET programmes
- Double the number of students in ASET programmes in at least ten countries in SSA
- Support high quality ASET programmes and centres of postgraduate studies and applied research in ASET disciplines in at least five additional universities in SSA
- Develop at least five regional TVET centres of excellence to train faculty of TVET institutions, enable resource sharing, quality assurance, and specialised training in emerging areas
- Develop a regional quality assurance mechanism for ASET programmes, benchmarked to comparable systems globally
- Establish high quality data systems and benchmarking of ASET programmes and institutions in at least ten countries in SSA

D.3.4 Sustainability of the results

PASET was set up with support from the World Bank and the partnership is based on voluntary engagement/commitment from participating countries. The idea is that African governments, in cooperation with the private sector take the lead in building ASET capacity.[52]

The objective is to build capacity across the region that would allow the initiatives of PASET to continue in the future, and to transfer the facilitating role of the World Bank to a host institution within a few years-time. In order to achieve these objects PASET is:

- Building its management capacity and a sustainable and viable financial model for the RSIF and the trust fund
- Currently working with the Association for African Universities to manage the Regional Scholarship and Innovation Fund (RSIF) and they are benefitting from support from the Institute of International Education (IIE)[53], a non-for-profit organisation, to manage and run the programme
- Building the capacity and training people to host the Regional Benchmarking Initiative. It is expected that this transfer of ownership will happen within the next two years, together with the establishment of the centre

D.4 Lessons learnt, changes over time

D.4.1 Key success and enabling factors in the approach identified

Three key success and enabling factors are identified[54] for building capacity in the field of ASET:

1. First, it is vital to support the development of high quality skills and capacity. To ensure implementation of best-practices, the PASET is set up with third country participation and technical support to introduce best practices from around the world
2. Second, it is highly important to achieve a critical mass of people with such high quality skills. The programme therefore has the ambition to contribute to the capacity building of 1,000 PhD students as part of the RSIF over a period of ten years
3. Third, it is argued that ensuring ownership of the programme by national governments and bodies in order to gain momentum of change and continue to building capacity across the region is essential

[52] ibid

[53] http://www.iie.org/

[54] Information collected based on an interview with World Bank representative.

D.4.2 Monitoring and evaluation practices and key indicators used

PASET is currently building its future monitoring and evaluation (M&E) strategy. For example, as part of the RSIF, PASET is working with IIE to build a platform that will be used for the M&E. This platform will monitor student performance and progress, what indicators will help to assess progress as well as the overall success of the initiative.

D.5 Transferability of the scheme

Some of the distinctive features that set PASET apart from some other development initiatives are presented in the table below.[55] Some of these are elements already incorporated into the design of EEEP, while others provide useful input for the upscaling of EEEP.

Table 5 Overview of distinctive characteristics and transferability

Distinctive characteristics	Transferability to EEEP
"Combining African Ownership and Leadership with Global Knowledge: The governments championing PASET have taken the lead in its governing bodies and in co-hosting its regional forums. They are also seeding PASET's Regional Scholarship and Innovation Fund for PhDs in ASET fields"	High - It is crucial to create ownership through engagement of the ley stakeholders to ensure sustainability of the results
"Focus on Priority Sectors: PASET is clearly focused on the skills needs of about ten sectors essential to Africa's structural transformation, including agriculture, mining, manufacturing, electrical power, infrastructure and construction, ICT, health and financial services, among others."	High - EEEP already applies a similar focus on a priority area
"Continuum of Skills: In contrast to other initiatives that focus on different education levels, PASET seeks to build a continuum of scientific and technical skills in its target sectors, from Technical and Vocational Education and Training (TVET) at upper secondary level to post-graduate level research".	Low – Revising ways to contribute to a broader continuum of skills development at different levels of education requires significant increase in grant size to avoid fragmentation of the grants
"Combining Regional and Country-Level Initiatives: A strong regional approach facilitates technical assistance, knowledge exchange and mobilisation of resources at regional as well as country levels".	High – through fostering networking among the funded HEIs such regional dimension could be strengthened
"Public and Private Sector Engagement: PASET engages with both public and private sectors, closely relying on the private sector for knowledge sharing, technical advice and resource mobilisation".	High – Although industry-academia collaboration is at the heart of EEEP, applying a more strategic way for engagement is needed
"Engagement with New Partner Countries: While Asian and Latin American countries are already engaged in Africa through private investments and assistance for TVET and science and technology, their own experiences also contain invaluable lessons. PASET aims to harmonise these efforts at country and regional levels to expand knowledge-sharing as well as raise the level and impact of their assistance in a focused manner."	High – The context of the IAPP provides valuable lessons for the EEEP programme, and vice versa

Source: http://documents.worldbank.org/curated/en/405111468197982834/The-partnership-for-skills-in-applied-sciences-engineering-and-technology-PASET & The Partnership for Skills in Applied Sciences, Engineering and Technology (PASET), October 2016

D.5.1 Suggestions, recommendations

The key of the (future) success of PASET may be the creation of capacity on the ground to ensure the sustainability of the programme. This also implies the creation of a financial model that is sustainable in the absence of the World Bank and/or can be supported from a distance. The approach of PASET is to share ownership on the group and build capacity and recommends likeminded programmes such as EEEP to follow the same approach.

[55] World Bank. 2016. The partnership for skills in applied sciences, engineering, and technology (PASET). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/405111468197982834/The-partnership-for-skills-in-applied-sciences-engineering-and-technology-PASET

Appendix E Development Partnerships in Higher Education (DelPHE)

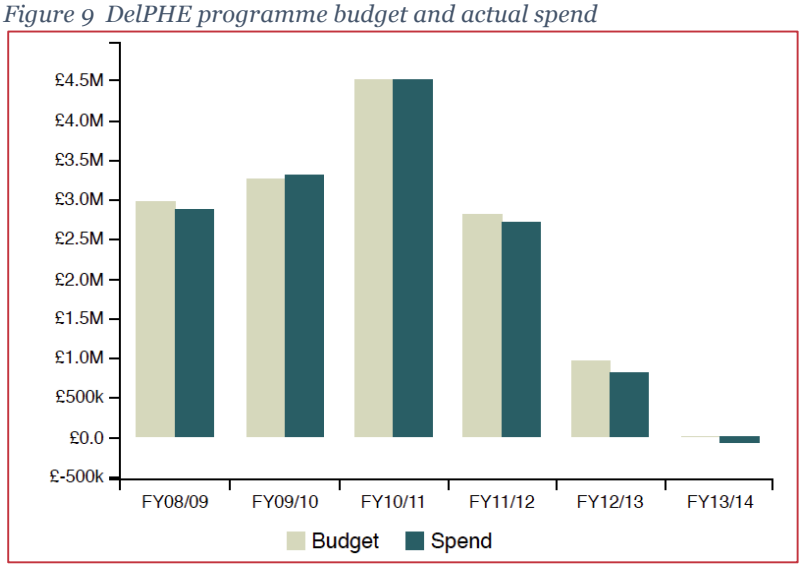
E.1 Description of the programme

DelPHE was implemented between 2006 and 2013. DelPHE was designed to build capacity in the higher education sector in DFID priority countries and thereby contribute to the reaching the United Nation's Development Millennium Development Goals (MDGs). DelPHE helped contribute to sustainable development and to also work horizontally with other academic institutions and vertically with policy makers. Partnerships between institutions in different countries were supported to enable them to undertake joint research, develop improved teaching programmes and share relevant ideas and expertise. The overall aim of the programme was to act as a catalyst for poverty reduction and sustainable development in accordance with the MDGs.

E.1.1 Key statistics: annual budget, success rates, changes over time

DFID invested £15 million in the DelPHE programme, including £12.5 million programme costs and £2.5 million admin cost. In addition, £3 million was invested to support Iraq. 200 projects have been established through 5 funding rounds, with approximately 40 new projects funded in each round.

Figure 9 DelPHE programme budget and actual spend



Source: DFID DevTracker Project GB-1-111543

DelPHE built on the experiences from the predecessor: Higher Education Links scheme (1981-2006), and was succeeded by the SPHEIR programme (since 2016) (see separate description in this annex). At the end of the DelPHE programme, an evaluation recommended continuing the programme with twice the budget. SPHEIR was launched a few years later and is not a direct continuation of DelPHE. For example, there was a change in emphasis on private partners compared to DelPHE.

E.1.2 Main implementing bodies

DelPHE was managed on behalf of DFID by the British Council in collaboration with the Association of Commonwealth Universities (ACU). The British Council had the main responsibility, drawing on overseas offices and staff to implement the programme.

The role of the Association of Commonwealth Universities (ACU) was to assist 'South-South partnerships' and was responsible for Trans-national dissemination of information and good practice arising from projects; Identification and support for potential south-south links that might be encouraged to submit applications for awards; Gathering intelligence on current university capacity; Identification of activities with particular potential for transformation into larger scale projects and

partnership funding from other international donors, and links with the Commonwealth Scholarship Commission.

E.1.3 Target audience, types of participants, variations among the countries

The programme was aimed at higher education institutions in 22 DFID Public Service Agreement countries, including South Africa, Mozambique, Tanzania, Zambia, Sierra Leone, Ghana, Kenya, Malawi, Nigeria, Uganda among others.

E.2 Mode of implementation

E.2.1 Key characteristics of the projects

Each project lasted three years and had an average budget of £65,000. In each partnership, the lead partner was always a higher education institution in a DFID priority country. Southern and smaller institutions that met the standards were prioritised for funding.

Partnerships could be bi-lateral (about 60%) or multi-lateral (40%), which could be applied for between two separate windows. Multi-lateral partnerships typically involved between three and five partners. The majority of the partnerships were between Southern and Northern partners but 22 of 'South-south' partnerships were facilitated by the Association of Commonwealth Countries (ACU).

There was no specific 'steer' from the funders, in terms of the subjects covered but in practice, most partnerships focussed on 'STEM' subjects. The need to demonstrate impact on policy and/or community practice meant that these subjects were favoured. The 200 projects included 47 focused on health-related areas, 37 on the environment and climate change, 30 on agriculture and veterinary areas, and 25 on education.

E.2.2 The level of support available – what does it cover (types of activities – networking, capacity building, knowledge sharing), how is it used

Grants from the DelPHE scheme covered a range of activities:[56]

- Joint research
- Development of new courses
- Networking and exchange of ideas
- Professional development
- Improved training of education and health workers
- Gender integration
- Policy development

E.2.3 Elements of international collaboration, academia-industry collaboration, curriculum development

International collaboration and curriculum development were important elements in DelPHE. The programme supported international collaboration through both North-South and South-South partnerships. Curriculum development was one important type of output from the programme as described below.

DelPHE had less focus on private sector engagement, an issue which came more to the fore in the successor programme, SPHEIR. Applicants were not explicitly encouraged to include NGOs and industry partners, but they were able to do so.

[56] DFID project completion review, p. 2

E.2.4 Complementarity / overlaps with other local or regional activities

The DelPHE scheme complemented other programmes in several ways. The scheme was designed to increase focus on achieving the Millennium Development Goals, a change from the previous programme. The programme also coincided with other commitments to increasing aid to education – for example from the G8, the Commission for Africa Report and the so-called 'Chancellor's papers'.[57] In addition, it aimed to meet the objectives of the Paris Declaration on Aid Effectiveness (2005) to ensure additional ownership to Southern partners.[58]

Another indication of the complementarity was the ability of partnerships to leverage funding from other sponsors and donors to continue their activities after the completion of DelPHE grants.

E.3 Main achievements, results of the programme

Figure 10 summarises the detailed output scoring provided in DFID's project completion review for DelPHE. Through the 200 projects were funded, DelPHE met the majority of the targets set for the programme.

Figure 10 DelPHE 'detailed output scoring'

Output dimension	Result achieved
1. Significant Joint Research	123 partnerships publishing at least one research paper in a recognised journal, living up to the target of minimum 120 partnerships doing so.
	68 institutions attracted additional funds as a result of DelPHE, exceeding the target of 30 institutions. More than £32 million (cash or in-kind) in additional funding was awarded to DelPHE partnerships from government and international donors between 2006 and 2013. In most cases, this extra funding was awarded to facilitate activities after the end of the DelPHE funding period.
2. Strengthened portfolio of MDG and science and technology programmes and courses in partner institutions	165 partnerships used the DelPHE seed funding to develop new or revised courses or modules at graduate and postgraduate levels during their DelPHE partnerships.
3. Increased staff and student capacity in partner Higher Education Institutions	37,613 individuals – 24,189 male (64%) and 13,424 female (36%) have benefitted from DelPHE professional development opportunities and courses.
	73 staff, students and other DelPHE beneficiaries have provided positive feedback on how being involved in DelPHE has enhanced their knowledge and skills and future opportunities.
4. Increased support for gender parity in HEIs contributing to the gender Millennium Development Goal (MDG)	The targets set for gender equality were not met during the DelPHE programme: 37% of project team members and 41% of participants in research and course development or benefiting from other DelPHE related activities were, short of the target of 45%. There is limited 'baseline' data available about gender participation in academia in Sub-Saharan Africa and so it is difficult to interpret the results. There was some evidence that less-well financed institutions were less inclined to promote female academics.
5. Improved national and international networking between partner HEIs	115 partnerships have participated in national and regional conferences or been involved in specialist seminars.
6. Improved institutional management and administration of partner HEIs	This was achieved. 156 (78%) out of the 200 partnerships had their finances managed by the southern partner to agreed criteria and in accordance with programme guidelines.
	171 projects have satisfactorily completed and submitted reports and supporting documentation within agreed timeframes.

Source: DFID project completion review

[57] DFID project completion review, p. 3.

[58] https://www.oecd.org/dac/effectiveness/parisdeclarationandaccraagendaforaction.htm

E.3.1 Key benefits delivered to the different types of participants

The benefits to different stakeholder groups are largely described above.

- Students could gain new and improved courses and teaching
- Academic staff could receive training and enlarge personal networks
- Institutions gained capacity and ability to leverage further funding
- Society more broadly could benefit from the attainment of Millennium Development Goals

E.3.2 Impacts

The expected **impact** was that Higher Education Institutions (HEIs) in partner countries would act as catalysts for poverty reduction and sustainable development. The indicator target for this was that by the end of the programme, 70% of DFID priority countries would be on target to meet MDG1. Whilst the target has been reached, it is not possible to calculate whether and how much DelPHE contributed.

Scored against the programme's main ***outcome*** indicators, DelPHE generally scored well:[59]

- *Number of MDG related research outputs from partnerships influencing local, regional or national policy:* 14 examples were observed where partnerships influenced policy. This was slightly below the target of 20. A broader measure of 'policy engagement', however, shows that 129 partnerships were involved in either policy engagement, policy influence, or policy change during the course of the programme[60]
- *Increased number of departments performing internationally recognised research, in support of the MDGs and Science and Technology*: 157 examples were observed, exceeding the targeted 120
- *Partnerships developed through DelPHE funding are sustained or intend to be sustained at least one year after completion of DelPHE funding*: 114 partnerships were sustained more than one year after completion of DelPHE

E.3.3 Sustainability of the results

Several features of the DelPHE programme aimed to support this sustainability of the partnerships:[61]

- The development of quality assurance systems
- The advancement of research expertise
- The provision of 'seed corn' funding and outreach strategies to attract additional funding if partnerships were successful
- Effective communication strategies between partners
- Local ownership of partnerships

As shown above, almost all partnerships completed the programme period and the majority of partnerships were sustained after the end of the programme, often with the help of additional funding from other donors. It was found, however, that the programme was more effective in creating and expanding individual linkages than links between institutions.[62]

E.4 Lessons learnt, changes over time

E.4.1 Key success and enabling factors in the approach identified

The variety of projects funded under the scheme makes it difficult to point to a uniform set of factors. The flexibility of the support was arguably a success factor. The scheme supported expansions of existing

[59] DFID project completion review, p. 18.

[60] DFID project completion review, p. 27.

[61] https://www.britishcouncil.org/partner/track-record/development-partnerships-higher-education

[62] DFID project completion review, p. 30.

partnerships through support for travel of Northern specialists, technical support and capacity building as well as smaller amounts of seed funding to build new networks.[63]

The South-South partnerships supported by ACU were unique in that there was a mutual understanding between partners of the challenges in developing countries faced.

The project review found that the DelPHE programme had been useful as a 'brand'. Being branded as a DelPHE partnership member allowed both Northern and Southern partners to add credibility and attract funding from other partners.

E.4.2 Main barriers overcome, possible solutions

The partnerships were deemed to be highly sustainable but it was observed that the links created through the programme were stronger at the individual rather than at the institutional level (see above). Thus, it remains a challenge to maintain the institutional networks after the end of the funding period.

Many Southern universities have limited experience managing international projects and, as such, the DelPHE programme provided an opportunity to build capacity in this space. Although Southern institutions were lead partners in all projects, it was reported that, in fact, Northern institutions often took over the management of the project.

As shown above, the programme did not meet the targets for female participation. It was suggested that there might be barriers related to attitudes and culture at the local level but DFID's project review concludes that a much broader effort is needed at the level of the institution, national policy as well as across DFID initiatives.[64]

E.4.3 Monitoring and evaluation practices and key indicators used

The programme outputs and outcomes were monitored in line with the project LogFrame, using the main indicators described above.

In addition, the Association of Commonwealth Universities carried out a series of studies towards the end of the programme to draw lessons for future programmes:

- DelPHE Country Case Studies Report: Evaluating the Impact and Sustainability of the DelPHE Programme, and Drawing Lessons for Future Schemes, DelPHE and ACU, November 2012
- HE Partnerships and Long-term Development: Evaluating the Impact and Sustainability of the DelPHE Programme, and Drawing Lessons for Future Schemes, DelPHE and ACU, July 2012
- Trends and Lessons in South-South Partnership Building Evaluating the Impact and Sustainability of the DelPHE Programme, and Drawing Lessons for Future Schemes, DelPHE and ACU, October 2011
- DelPHE South-South-Partnership Case Studies: Unique Impacts, Lasting Legacies, DelPHE and ACU, March 2013

E.5 Transferability of the scheme

The DelPHE programme had several features in common with the EEEP which would suggest that some lessons may be transferable from DelPHE to EEEP. They both focus on building capacity within higher education institutions (mostly) in Sub-Saharan African. The table below summarises some of DelPHE's distinguishing features and provides an assessment of the degree of transferability.

[63] DFID Project completion review, p. 31

[64] DFID Project completion review, p. 9

Figure 11 DelPHE – assessment of transferability

Distinctive characteristics	Transferability to EEEP
DelPHE focused explicitly on UN Millennium Development Goals, providing complementarities with other international initiatives and increases the prospect for attracting additional funding.	Medium – the focus of the EEEP also enables seeking complementarities with other programmes, thereby additional funding
DelPHE aims to build capacity for research and development, as indicated by journal publications	Low – EEEP does not support research specifically, it has a clear focus on education
DelPHE funded 22 examples of South-South partnerships with focus capacity building in project management within Southern institutions. This included taking some risks by providing small scale grants to institutions with limited prior experience and institutional capacity for managing externally funded projects with smaller grants.	High – EEEP is composed of South-South consortia and an increased role of Spoke universities in combination with the need to build their project management capacity has been an area of interest to the programme.

Appendix F Strategic Partnerships for Higher Education Innovation and Reform (SPHEIR)

F.1 Description of the programme

The Strategic Partnerships for Higher Education Innovation and Reform (SPHEIR) programme was launched by DFID in January 2016 building on the previous 'Development Partnerships for Higher Education' (DelPHE) programme (2006-2013). The aim of the programme is to "transform the quality, relevance, access and affordability of higher education to achieve sustainable change in higher education (HE) systems."[65] Partnerships funded by the programme can address either or both of two main dimensions:

- ***Higher education delivery***: improving the content and delivery and teaching methods within single departments, faculties or universities, or collaborative across institutions or even countries
- ***Higher education enabling systems***: strengthening system and institutions, addressing issues such as governance, quality assurance, accreditation and financing

SPHEIR focus countries include certain low-income and middle-income countries located across Sub-Saharan Africa, Asia and the Middle East, including most of the countries DFID works with.[66] Eligible countries for the 2016/17 'open' call for partnerships include:[67]

> *Afghanistan, Bangladesh, Burma,* ***Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Liberia, Malawi, Mozambique,*** *Nepal,* ***Nigeria****, Occupied Palestinian Territories, Pakistan,* ***Rwanda, Sierra Leone, Somalia, Sudan, South Sudan, Tanzania, Uganda****, Yemen,* ***Zambia and Zimbabwe***[68]

The partnerships may include organisations from any country, including from the 'Global North' and middle-income countries, but the 'significant majority of primary beneficiaries' should be located in the target countries.[69]

The programme focusses on university education and can include any university degree programme. Technical and vocational training is not in scope but could also benefit from partnerships aiming for system-level reform.[70]

[65] *Concept Note: SPHEIR Open Call for Partnership Proposals*, SPHEIR programme management, September 20, 2016

[66] https://www.gov.uk/government/organisations/department-for-international-development/about

[67] *SPHEIR: Guide for applicants – SPHEIR call for proposals: 21 October 2016 to 20 February 2017*, p. 5

[68] Note: countries from Sub-Saharan Africa are bolded

[69] *SPHEIR Technical Clarification*, 7 November

[70] *ibid*

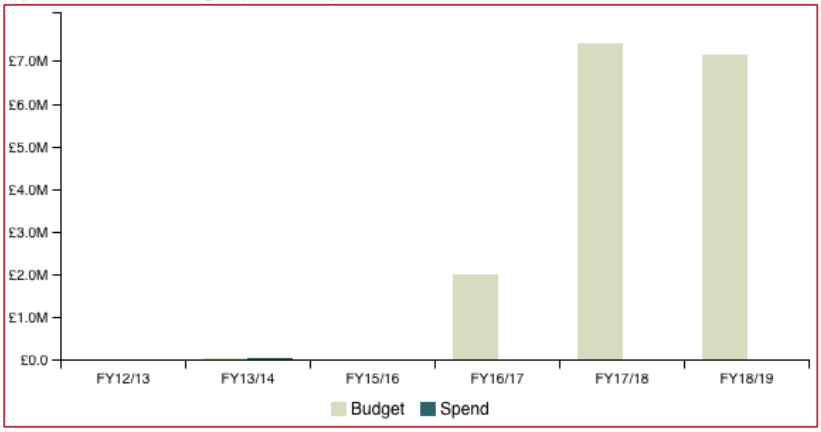
F.1.1 Main implementing bodies

SPHEIR is established by the UK Department for International Development (DFID). The programme managed on behalf of DFID by a 'Fund manager', a role undertaken by a consortium led by the British Council with PwC and Universities UK International (UUKi).

F.1.2 Key statistics: annual budget, success rates, changes over time

As the SPHEIR programme only began in January 2016, it is still in its infancy. The value of the initial contract between DFID and the Fund Manager is £43,564,205 and it will run for 6 years. Depending on demand, there is the potential for the project budget to increase to a maximum of £100m and extended for a further 4 years. All partnerships are to be concluded by the end of 2025. The annual budget is set to reach approximately £7 million per year from 2017/18.

Figure 12 SPHEIR project budget



Source: DFID Development Tracker: SPHEIR[71]

F.1.3 Target audience, types of participants, variations among the countries

The SPHEIR Fund Manager has defined the main groups of potential beneficiaries as follows:[72]

- ***Primary (direct) beneficiaries*** must be those directly targeted by project activities, for example students and teaching staff, academic support staff, and staff of regulatory or other higher education bodies who will receive course, training or other forms of support from delivery of project activities
- ***Secondary (direct) beneficiaries*** may include a broader group such as: i) additional students and teaching staff who benefit from knock-on effects from project activities e.g. staff from elsewhere in a university trained who are not directly involved in the project; ii) employers of primary beneficiaries, for example universities themselves and any employer of graduates
- ***Indirect beneficiaries*** are invariably present, and may include those in broader society indirectly impacted by a project. For example, a programme which trains nurses could consider children or families as indirect beneficiaries

In the assessment of applications, the SPHEIR team will focus on primary beneficiaries and how they will benefit.

In terms of overall sector groups, the higher education sector is expected to be the main recipient of funding (80%), whereas 10% is expected to be allocated to each of the two groups, 'Educational research' and 'Education policy and administrative management'.[73]

[71] https://devtracker.dfid.gov.uk/projects/GB-1-203166/

[72] Open call concept note, p. 11

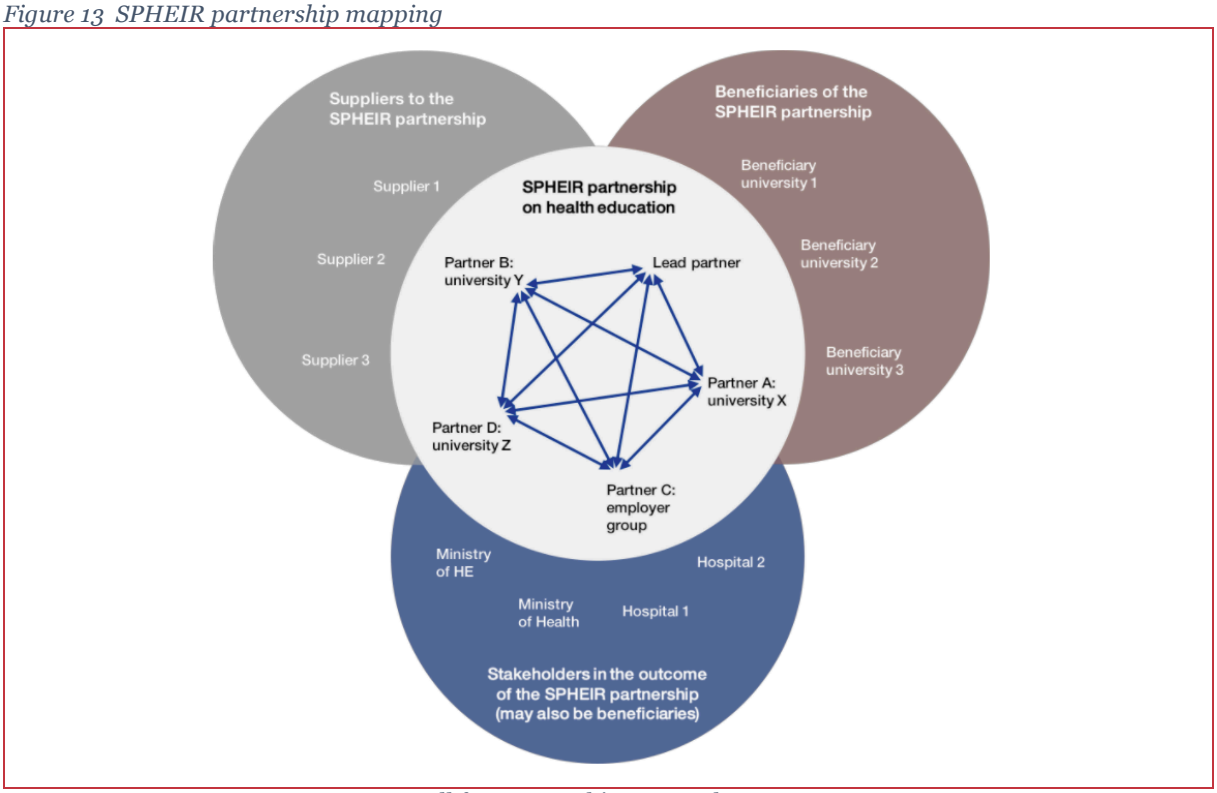
[73] https://devtracker.dfid.gov.uk/projects/GB-1-203166/

F.2 Mode of implementation

F.2.1 Key characteristics of the project

The first phase (2016-2021) will cover a portfolio of some 12 partnerships. In SPHEIR, partnerships are defined as "formal collaboration among a group of public and/or private organisations that address HE in ways, and at a scale, that a single organisation cannot."[74] Each partnership can consist of two or more organisations and its size should be determined by the nature and aim of the partnerships. The lead partner submits the applications, coordinates the project, is responsible for SPHEIR project funding and accountable to the Fund Manager. Even so, every partner should have a clearly defined role within the partnership. Organisations outside the formal partnership can be involved as for example suppliers, beneficiaries or key stakeholders, as illustrated in Figure 13.

Figure 13 SPHEIR partnership mapping



Source: Concept Note - SPHEIR Open Call for Partnership Proposals, p. 13

The first two partnerships were announced in September 2016 following a call for 'demonstration projects' open from May to July 2016. Both 'demonstration projects' are 5 years in length and will be the longest in duration within the portfolio. In terms of project focus, the demonstration call was looking to fund one project explicitly targeting higher education for beneficiaries affected by the Syrian crisis and one project involving innovation in technology enhanced learning (TEL) in higher education in Sub-Saharan Africa.[75] The two selected demonstrator partnerships are described in Figure 14.

Figure 14 Description of SPHEIR Demonstrator Partnerships

Title	Prepared for Practice	Partnership for Digital Learning and Increased Access
Partners	King's College London (UK) (Lead), Amoud University (Somaliland), Edna Aden University and Teaching Hospital (Somaliland), University of Hargeisa (Somaliland), Medicine Africa (UK),	King's College London (UK) (Lead), Kiron Open Higher Education GmbH (Germany), FutureLearn (UK), Al al-Bayt University (Jordan), and the American University of Beirut (Lebanon).

[74] Concept note, p. 12

[75] *Guidance for Applicants* [demonstration partnerships]

Title	Prepared for Practice	Partnership for Digital Learning and Increased Access
	and the Tropical Health and Education Trust (UK).	
Expected duration	5 years	5 years
Description	Interactive Health Education in Somaliland aims to support higher education institutions in Somaliland to develop the capacity and resources to sustainably produce graduates across health worker cadres with the necessary knowledge, skills and behaviours to enter practice at an effective level. It will do this by using technology enhanced and blended learning to reach current students, faculty and clinicians to make them better 'prepared-for-practice', and create a postgraduate environment that supports continued interactive professional development and learning.	The overarching objective of the Partnership for Digital Learning and Increased Access (PADILEIA) project is to produce high-quality, blended higher education programmes that will enable displaced Syrian students in Jordan and Lebanon to integrate more fully into the local workforce and, in the future, help to rebuild the post-conflict Syria. Students will be offered curricula that provide micro-credentials in industry-relevant fields, augmented by employability skills training, employment support services, and affordable pathways into locally-delivered formal academic qualifications.

Source: http://www.spheir.org.uk/partnership-profiles

The second 'open' call for partnerships is open between the 21 October 2016 and the 20 February 2017. This call will fund up to 10 partnerships for between 2 and 4.5 years in duration.

F.2.2 The level of support available

Applications are expected to fall within the following cost brackets:

- Between £1 million and £2 million
- Between £2 million and £3.5 million
- Between £3.5 million and £5 million
- Over £5 million

Most partnerships are expected to cost between £1 million and £5 million but costs over £5 million may be considered in exceptional cases, where evidence of catalytic systemic transformation can be provided. The SPHEIR team plans to select a 'balanced portfolio of projects with different values'.[76]

SPHEIR prioritises projects that build capacity for higher education delivery within the target country and as such, include supporting knowledge sharing activities between the partners and capacity building within the HE intuitions. The two pilot partnerships both address direct delivery of HE through ICT enhanced learning, facilitating graduate employability and addressing the needs of the labour market. Throughout the projects, technology facilitate learning is complemented by other activities such as the development of MOOCs, classroom based learning and other blended learning approaches.

Major capital expenditure, core institutional costs and research grants are generally ineligible for funding under SPHEIR.

F.2.3 Elements of international collaboration, academia-industry collaboration, curriculum development

SPHEIR activity encourages **international collaboration**, including North-South and South-South partnerships: [77]

[76] SPHERE open call guidance for applicants, p. 7.

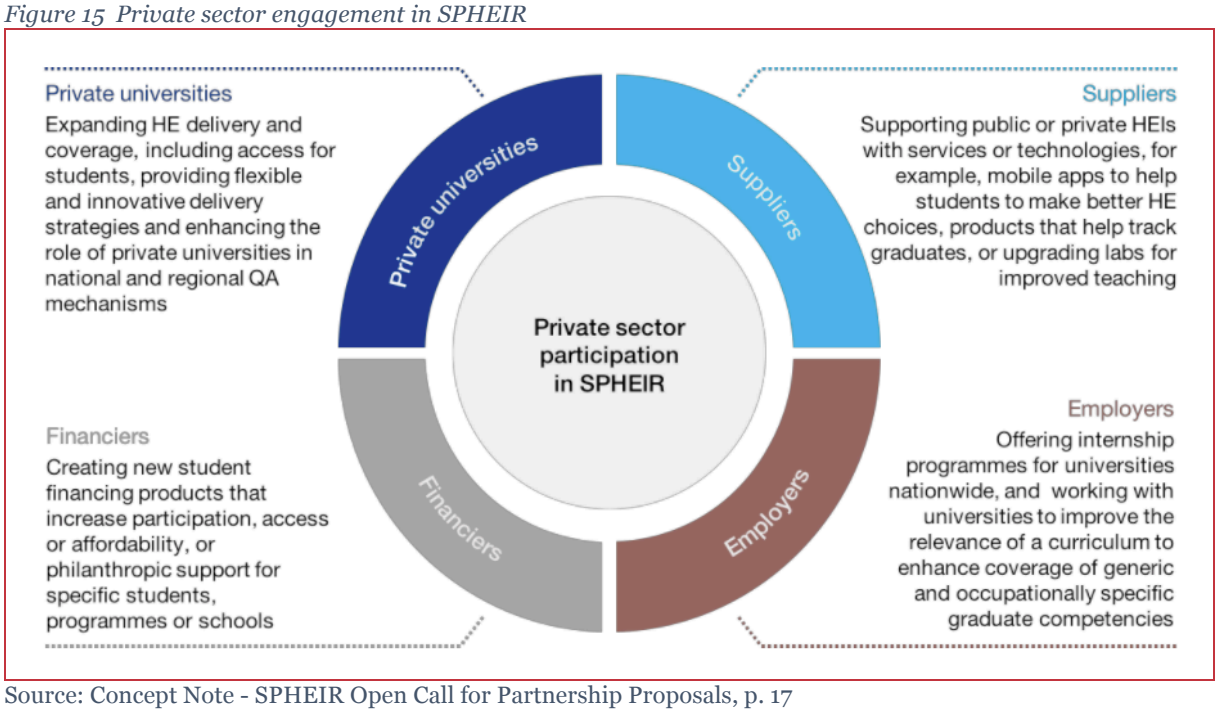
[77] Concept Note: SPHEIR Open Call for Partnership Proposals, pp. 16-18

- *North-South* collaboration provides an opportunity for low-income countries to draw on experience and recognised education expertise in the UK and other Northern countries. Imperial College London is the lead partner in both 'demonstration' partnerships
- Collaboration with *middle-income countries* in the 'global south' can provide lessons from countries that have recent experience from higher education reform
- There is equally a large potential for *South-South* collaboration within the programme. The fact that a large proportion of the target countries are located in Sub-Saharan Africa provides opportunities for partnerships with multiple institutions and/or countries. During the British Council's Going Global conference in 2016, African academic leaders called for more intra-African initiatives, supporting the case for South-South partnerships. In addition, this can build on existing networks and organisations within the region

International partners are not mandatory, but encouraged provided that their inclusion contributes to strengthening higher education in the target countries.

Compared to the previous DelPHE programme, SPHEIR has an increased focus on encouraging new actors, especially from the **private sector**, to engage in higher education. For example, employers are seen as 'secondary beneficiaries' in the programme and should have an interest in developing local graduates and enhance their brand or republication through visible public investment in local higher education institutions. All applicants are expected to include some form of engagement with private or public employers in their proposal, and the SPHEIR team will actively assist partnerships to develop private sector engagement strategies.[78]

Figure 15 Private sector engagement in SPHEIR



Source: Concept Note - SPHEIR Open Call for Partnership Proposals, p. 17

Curriculum development is one of the main levels of intervention that partnerships can choose to focus on, either directly through a targeted initiative to re-design courses or more systemically to develop capacity for ongoing curriculum development.[79]

[78] Concept Note: SPHEIR Open Call for Partnership Proposals, pp. 16-18

[79] Ibid

F.2.4 Complementarity / overlaps with other local or regional activities

There are already higher education networks and formal collaborative institutional arrangements in Sub-Saharan Africa, and SPHEIR is open to building on existing networks and organisations, and sees this as preferable to the establishment of new Pan-African or regional organisations.[80] The two 'demonstration partnerships' were specifically required to be based on existing networks and capabilities to ensure that implementation could start without delay. [81]

F.2.5 The main reasons for this mode of implementation and the advantages/disadvantages

The two partnerships selected for funding so far are 'demonstration projects' and needed to be launched quickly. As such, the lead partner of the projects needed to be experienced at technology enhanced learning and HE delivery. Thus, both current projects are led by a UK university.

By facilitating partnerships of multiple large organisations and institutions, it is hoped that these projects will create lasting and sustainable transformation of the HE system in those target countries. Considerations for project selection include the capacity for the project to feasibly make changes to policy, and the capacity of the project to be scaled up to regional or national levels.

The potential methods of intervention for SPHEIR are varied and depend upon the focus and objective of the project. These interventions may have impact from the system level to the program delivery level.

F.3 Main achievements, results of the programme

F.3.1 Results, achievements of the programme

No partnerships have yet reached the stage of producing results. The partnerships will all be different and aim to achieve different results but examples could include the following:[82]

- Enhancing quality in higher education delivery
- Ensuring relevance of higher education programmes and institutions
- Broadening access to higher education
- Improving affordability

F.3.2 Key benefits delivered to the different types of participants

The primary beneficiaries of these projects are those directly engaged with HE programme (university staff and students) in the form of both capacity building and skills improvement.

Indirect beneficiaries include the wider societies within which the projects are based. For example, the 'Prepared for Practice' project will have an indirect impact upon the people in need of health care within that area as practitioners will be better trained. More directly, the teaching hospitals partnering within this project will directly benefit from higher degree of skills of staff and knowledge transfer.

F.3.3 Impacts

This will depend on individual partnerships. Impact can be achieved at the level of individual courses or at the system level. Applicants are encouraged to consider how they will determine whether they have achieved impact.

F.3.4 Sustainability of the results

In proposals, applicants are expected to consider the sustainability of the project's outcomes beyond the SPHEIR funding period and this is an important criterion in the assessment of proposals. 'Sustainability

[80] Concept note, p. 10

[81] *Guidance for Applicants* [demonstration partnerships], p. 5

[82] *Concept Note: SPHEIR Open Call for Partnership Proposals*, SPHEIR programme management, p. 5

and cross-cutting issues' – including issues such as local capacity and ownership, affordability and equity of access – account for 20% of the overall assessment.[83]

The aim is that partnerships and capacity built within the target countries should be self-sustaining after the funding period. It is considered that partnerships that continue to rely on organisations outside the target countries is considered less likely to be sustainable.[84]

F.4 Lessons learnt, changes over time

F.4.1 Key success and enabling factors in the approach identified

One of SPHEIR's main ambitions is to bring about *transformation* but by its nature, such changes are likely to be complex and involve long time-scales. Consequently, this can be difficult to observe and measure. In many cases, the time-scales will be such that the effects of the transformation – e.g. student employability – will manifest itself only after the end of the project. Projects are therefore asked to develop clear theories of change and devise methods to measure transformations after the end of project.

F.4.2 Main barriers overcome, possible solutions

SPHEIR is looking for *innovative* projects but it is understood that this is also inherently risky. To find genuinely innovative projects, the Fund Manager is willing to accept that results from such innovative projects cannot be guaranteed in advance and that some may fail to achieve their targets.[85]

F.4.3 Monitoring and evaluation practices and key indicators used

The SPHEIR programme has set out monitoring and evaluation (M&E) principles at the project and programme level. At the level of individual projects, applicants are expected to present a 'theory of change' in their application. Some support is provided by the SPHEIR management team but it is recommended that applications include partners with experience in monitoring and evaluation. According to the programme guidance note, the first phase of a grant period (e.g. 5 months) will be used for preparation. This includes the development of a M&E system with a theory of change and a log frame that corresponds to that of the overall programme. During subsequent phases, results will be monitored in accordance therewith and in the last phase of the grant, there is again a focus on M&E and lesson learning.[86]

At the programme level an external Evaluation Manager will be appointed to work alongside the Fund Manager throughout the programme cycle from 2016 to 2025. Because of the pioneering nature of the programme, this will have to be done in a highly adaptive fashion as the programme unfolds. Among the Evaluation Manager's responsibilities will be:

- Test the assumptions of the programme theory
- Support ongoing monitoring and evaluation of individual partnerships
- Produce and synthesise key findings to report on impact and value for money
- Build a strong evidence base, together with knowledge and evidence of "what works" and "what does not work"
- Collaborate with the Fund Manager in devising a strategy to feedback lesson-learning into programme implementation[87]

[83] SPHEIR Guidance for applicants, pp. 7, 11

[84] Call for proposals, p. 10.

[85] Concept note pp. 15-16

[86] Concept note, p.11, 19

[87] Presentation: Strategic Partnerships for Higher Education Innovation and Reform (SPHEIR)

F.5 Transferability of the scheme

The table below summarises some of SPHEIR's distinguishing features and provides an assessment of the degree of transferability.

Figure 16 Transferability of practice - SPHEIR

Distinctive characteristics	Transferability to EEEP
Monitoring and Evaluation: SPHEIR requires applicants to define a 'theory of change' with their applications and further commits the first phase of the project to develop a detailed theory and log frame.	High – EEEP could have more focus on these aspects and support project partners proactively in developing a sound programme logic in the first stages of the project. This will provide a basis for more systematic monitoring and evaluation throughout the project cycle.
Role of partners: SPHEIR partnerships require that each partner has a defined role and is necessary for the successful implementation of the project. This forces applicants to consider the composition of their consortia very carefully.	High – EEEP could articulate more clearly what the role of the spoke universities should be and how their participation contributes to the overall project
Scale and scope: The funding available for each partnership in SPHEIR (typically between one and five million GBP) is about ten times that of the typical EEEP programme. Similarly, the range of activities and subjects covered are much wider, the duration can be longer, and the level of transformation expected from each partnership is higher than in the Academy's projects	Low – EEEP does not have the funds available to fund projects at the same scale as SPHEIR. EEEP therefore needs to focus more on essential aims.
System transformation: SPHEIR has a more explicit focus on 'enabling systems' than was the case in EEEP. Given the more limited scale and scope of EEEP compared to SPHEIR, the Academy could consider identifying a limited number of key systematic issues and associated stakeholders that could addressed to enable the achievement of the programme goals. The Academy could request of the participants that they have considered these framework issues and have the support of relevant stakeholders. Based on feedback from EEEP projects these could include	Medium – EEEP projects cannot target system transformation at the same scale as SPHEIR but the role of issues like governance bodies, accreditation and staff development could all be articulated more clearly with the context of EEEP.
Focus on ICT: SPHEIR encourages the use of ICT to enhance learning and teaching, including in their first 'demonstration partnerships'.	Medium – This is not currently the case in EEEP but could fit within projects on a case-by-case basis. ICT solutions that rely on advanced infrastructure (e.g. fast internet) are less likely to be relevant.

Main sources

- *Concept Note: SPHEIR Open Call for Partnership Proposals*, SPHEIR programme management, September 20, 2016, available at: http://www.spheir.org.uk/sites/default/files/call_for_spheir_partnership_proposals_concept_note.pdf
- *SPHEIR: GUIDANCE FOR APPLICANTS - SPHEIR call for proposals: 21 October 2016 to 20 February 2017*, SPHEIR programme management, available at: http://www.spheir.org.uk/sites/default/files/spheir_guidance_for_applicants_21_oct.pdf
- *Concept Note: SPHEIR Demonstration Projects Using Technology Enhanced Learning in Higher Education*, SPHEIR programme management, 23 May 2016, available at: http://www.spheir.org.uk/sites/default/files/spheir_demonstration_partnerships_concept_note.pdf

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- *SPHEIR Open Call Information Session*, Presentation, 28 September 2016, Nairobi, Kenya, available at: http://www.spheir.org.uk/sites/default/files/spheir_open_call_info_session.pdf

Appendix G Regional fiches

Table 6 Overview of Sub-Saharan Africa

Main section	Indicators	West SSA	East SSA	Central SSA	South SSA
 Demographic framework conditions	Number of countries	16	10	7	15
	Most populous countries	Nigeria and Ghana	Ethiopia and **Tanzania**	Cameroon and Chad	The Democratic Republic of Congo and South Africa
 Economic framework conditions	Countries with highest GDP per capita	Cabo Verde and Nigeria	Sudan and **Kenya**	Equatorial Guinea and Gabon	Seychelles and Mauritius
	Countries with highest five year average GDP per capita growth	Mali and Ghana	Ethiopia and Eritrea	Cameroon and Gabon	The Democratic Republic of Congo and **Mozambique**
	Countries with the highest level of government expenditure on educational institutions as % of population	Ghana and Cote d'Ivoire	Rwanda and **Tanzania**	St Tome and Principe and Cameroon	Mauritius and South Africa
	Countries that score high on the infrastructure indicator	Cote d'Ivoire and Gambia	Rwanda and **Kenya**	Gabon and Cameroon	Namibia and Seychelles
	Countries with a large share of employed engineers	Ghana and Benin	Rwanda and Burundi	Cameroon and Chad	Madagascar and Mauritius
 Human capital development framework conditions	Countries with a high percentage of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes	Guinea and Cabo Verde	Ethiopia and Burundi	Congo, Rep	Angola and **Zimbabwe**
	Countries with a large number of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes	Ghana and Guinea	Ethiopia and **Tanzania**	Congo, Rep	South Africa and the Democratic Republic of Congo
 Regional organisations and engineering organisations	Regional organisations	WAFEO (8 members) ECOWAS (15 members)	EAFEO (4 members) EAC (6 members) SACMEC (3 members)	CAFEO (3 members)	SAFEO (11 members) SADC (14 members) SACMEC (13)
 Higher education and research institutions	Countries where the top ten HEIs listed in the Ranking Web of Universities are located	Nigeria (7), Ghana (2), Senegal (1)	**Kenya** (4), Ethiopia (2), **Tanzania** (2), **Uganda** (1), Sudan (1)	Cameroon (9), Central African Republic (1)	South Africa (10)
	Africa ranking of the top ten HEIs - range	[19-59]	[8-76]	[102-571]	[1-16]

Main section	Indicators	West SSA	East SSA	Central SSA	South SSA
 Engineering associations	Presence of engineering associations	Several examples of engineering associations are listed in Table 10	Several examples of engineering associations are listed in Table 14	Some examples of engineering associations are listed in Table 18	Several examples of engineering associations are listed in Table 21
 Employer associations and major employers	Number of countries that have IOE member organisations	12	6	4	13
	Number of companies that are in the top 250 Africa Businesses ranking[88] that are active in sectors related to engineering	13, located in Cote d'Ivoire, Ghana, Nigeria and Senegal	4, located in Ethiopia, **Kenya** and Sudan	0	58, out of which 55 located in South Africa and the remaining in Mauritius and **Zimbabwe**
 National policy makers	Ministries in change of education, science and technology	Various ministries in change of education, science and technology			
 International schemes and initiatives	Number of countries that are members of the Africa-EU partnership – Tuning Africa	9	10	12	13
	Winners of the 2015-2016 RAEng Africa Prize for Engineering Innovation	Ghana, Burkina Faso and Nigeria	**Uganda**, **Kenya** (3) and **Tanzania**	Cameroon	**Zimbabwe**, and South Africa (2)

In bold are the countries that have already been involved in the EEEP (Uganda, Kenya, Tanzania, Mozambique, Zimbabwe, Botswana, and Namibia - http://www.raeng.org.uk/publications/other/enriching-engineering-education-programme)

[88] http://www.theafricareport.com/top-500-companies-in-africa-2013.html

Overview of the developments in Sub-Saharan Africa

1 Introduction

1.1 Overview

This chapter looks at the development in Sub-Saharan Africa (SSA) in relation to building engineering capacity. The analysis covers four geographic regions in SSA: West SSA, East SSA, Central SSA, and South SSA – as illustrated by means of Figure 17 and Table 7.

Figure 17 Sub-Saharan African regions

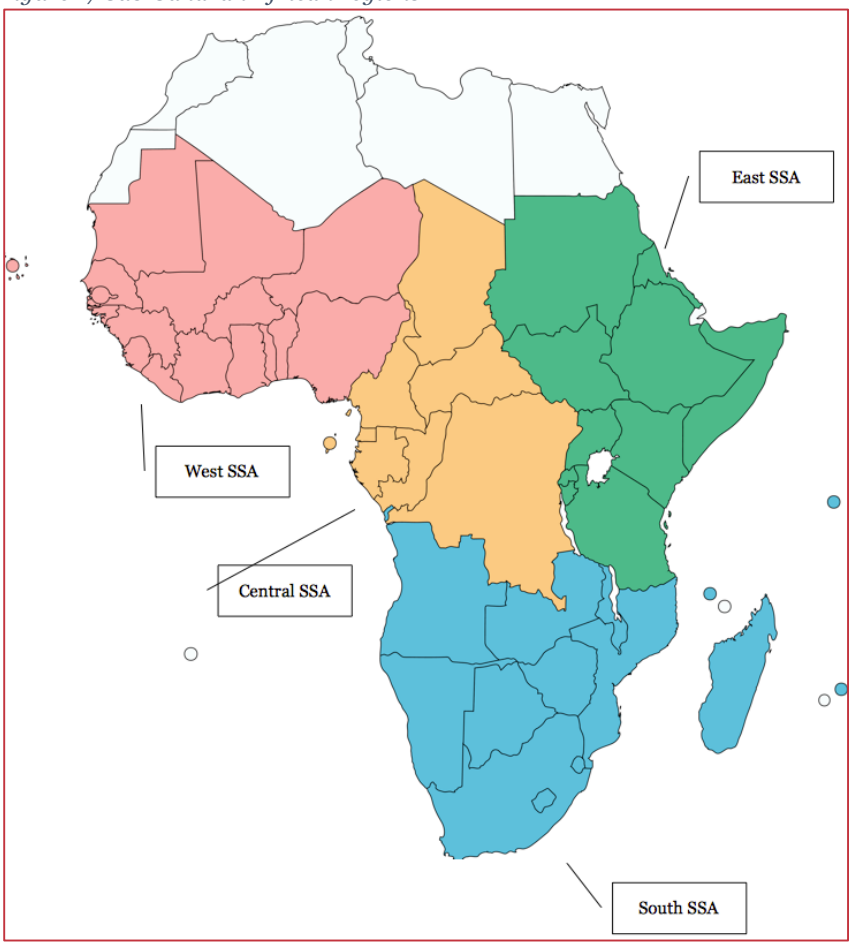


Table 7 Sub-Saharan African[89] countries by region

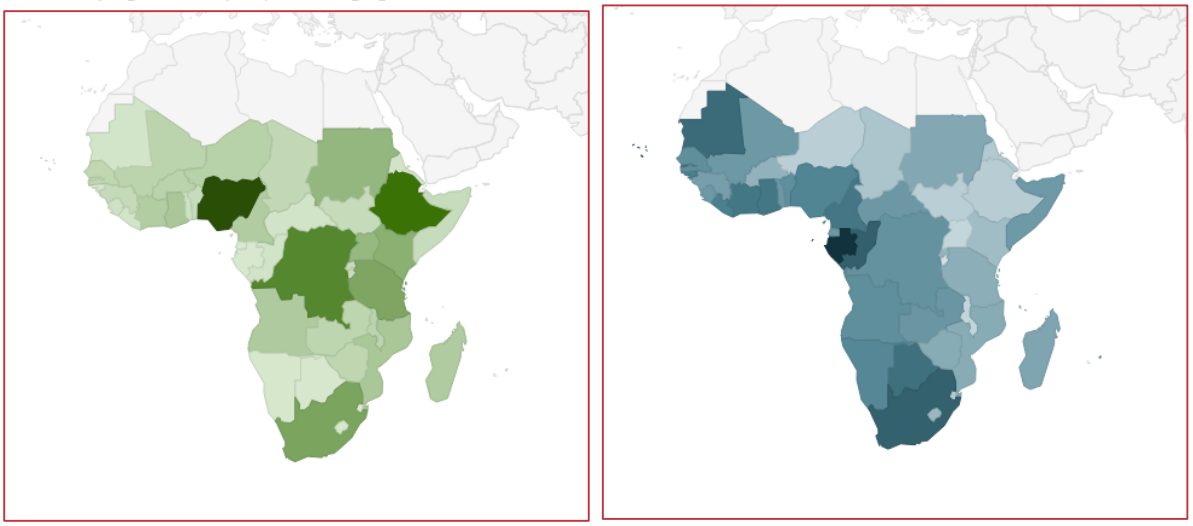
East	South	West	Central
Burundi	Angola	Benin	Cameroon
Eritrea	Botswana	Burkina Faso	Central African Republic
Ethiopia	Comoros	Cabo Verde	Chad
Kenya	Democratic Republic of Congo	Côte d'Ivoire	Congo, Rep.
Rwanda	Lesotho	Gambia	Equatorial Guinea
Somalia	Madagascar	Ghana	Gabon
South Sudan	Malawi	Guinea	Sao Tome and Principe

[89] http://data.worldbank.org/region/sub-saharan-africa

East	South	West	Central
Sudan	Mauritius	Guinea Bissau	
Tanzania	Mozambique	Liberia	
Uganda	Namibia	Mali	
	Seychelles	Mauritania	
	South Africa	Niger	
	Swaziland	Nigeria	
	Zambia	Senegal	
	Zimbabwe	Sierra Leone	
		Togo	

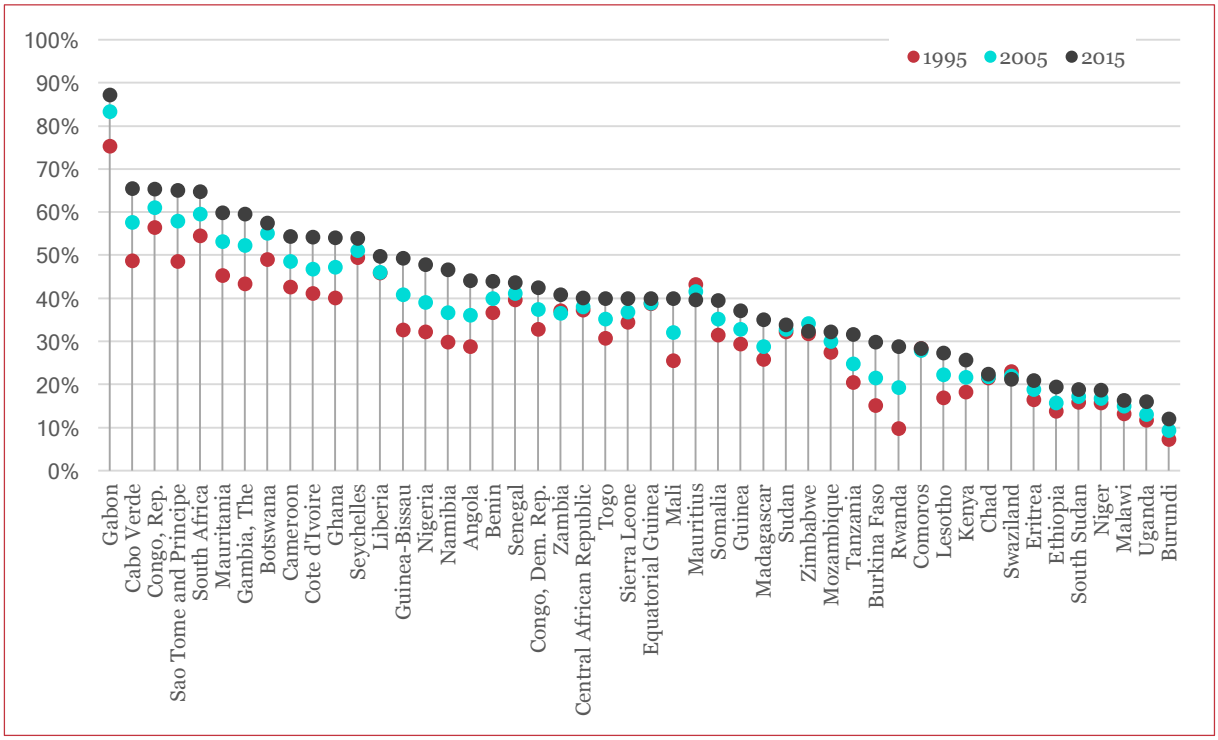
There is a substantial variation in the demography of Sub-Saharan countries. Population ranges from 182 million in Nigeria, 99 million in Ethiopia, and 77 million in the Democratic Republic of Congo to around 92,000 in Seychelles, 190,000 in Sao Tome and Principe, 520,000 in Cabo Verde and 788,000 in Comoros (data from United Nations World Population Prospects). Countries with a higher percentage of urban population include Gabon (87%), Cabo Verde (65%), and the Republic of Congo (65%). Countries that have a larger rural population include Burundi (12% urban population), Malawi and Uganda (urban population is around 16% in both counties). In some SSA countries, the percentage of urban population has increased substantially in the past 20 years – see Figure 19. For example, the percentage of urban population has almost tripled from 10% in 1995 to 29% in 2015. In Burkina Faso the percentage of urban population doubled to 30% in 2015. Many SSA countries that already had significantly high urban population in 1995 also saw substantial increases – e.g. in Gabon the percentage of urban population was 78% in 1995 and 87% in 2015.

Figure 18 Population statistics - To the left - Total population in SSA. Darker shades represent countries that have a higher total population. To the right – Percentage of urban population. Darker shades represent countries that have a high percentage of urban population



Source: United Nations World Population Prospects. Data from Eritrea is from 2011, all other data is from 2015.

Figure 19 Increase in urban population 1995-2015



Source: United Nations World Population Prospects. Data from Eritrea for 2015 is from 2011, all other data is from 2015, 2005, and 1995 respectively.

1.2 The African Union's Strategy

The 1980 Lagos Plan of Action for Economic Development has been cited as one of the frameworks that elaborated the role of "ST&I in solving problems including energy deficiency, food insecurity, environmental degradation, disease and water scarcity as well as boosting industrial productivity".[90] The Lagos Plan of Action called upon African countries to spend at least 1% of the GDP on R&D.

The 2005 Science and Technology Consolidated Plan of Action (CPA)[91] set out to consolidate science and technology programmes of the African Union (AU) and the New Partnership for Africa's Development (NEPAD). The plan for action identified four priority areas:

- Biodiversity, biotechnology and indigenous knowledge
- Energy, water and desertification
- Material sciences, manufacturing, laser and post-harvest technologies, and
- ICT, space science and technologies.

In relation to engineering, the CPA recognises, amongst other, that Africa's low investment in ST&I is related to the declining quality of science and engineering education - for all levels of the educational system. The CPA calls upon the role of HEIs in building engineering capacity. The action plan recognises that many African institutions have difficulty in recruiting and retaining postdoctoral researchers and lecturers in engineering courses and that there is a weak link between HEI and industry. The focus of the programme is to revitalise engineering training in HEIs. The specific objectives are the following:

[90] UNU-MERIT (2015) Policy brief. Innovation for Development in Southern & Eastern Africa: Challenges for Promoting ST&I Policy

[91] Africa's Science and Technology Consolidated Plan of Action

- Improving the state/quality of infrastructure and curriculum for engineering training
- Promoting the sharing of equipment among higher education institutions to maximum impact on improving engineering capacity
- Strengthening inter-university networking to share training staff and research experiences; and
- Strengthening university-industry partnerships to ensure that engineering training is relevant to economic production and industrialization priorities

Two specific projects related to engineering were (with initial time lines for 2006-2010): Project 1 - Assessment of Engineering Infrastructure and Curriculum of Higher Education Institutions and Project 2 - Promoting University-Industry Partnerships for Engineering Training.

The 'Science, Technology and Innovation Strategy for Africa 2024 (STISA- 2024) is the successor of the CAP. This new strategy was developed building on wide public consultation. The strategy identifies six science, technology and innovation priorities[92] and the delivery rests on four pillars:

- Building or upgrading research infrastructure
- Enhancing professional and technical competencies
- Promoting entrepreneurship and innovation, and
- Providing an enabling environment for science, technology and innovation development.

The emphasis on the importance of engineering is somewhat less pronounced in the strategy document but the strategy plan does refer to the use of engineering applications to develop and maintain scientific equipment and the need for partnerships between scientists and engineers.

According to a review by UNECA, Africa's science, technology and innovation performance has not improved in relation to the policies implemented. One of the reasons identified is that African Tertiary education institutions score low on global ranking.

1.2.1 Key international and Pan-African organisations and mechanisms for cooperation

1.2.1.1 FAEO

A number of SSA countries are member of FAEO – see Figure 20. FAEO is an international organisation that represents the engineering profession and was founded in 1968 with support from UNESCO.

[92] Eradicating hunger and achieving food security; preventing and controlling disease; building communication and transport infrastructure (for physical and intellectual mobility); protecting the integrity of African resources and "space"; "live together—build the society"; and wealth creation.

Figure 20 FAEO membership in Africa

1.2.1.2 Africa-EU Partnership

The Africa-EU Partnership[93] is the formal channel through which the EU and the African continent cooperate. It is based on the Joint Africa-Europe Strategy - adopted following the EU-Africa Summit in 2007. The strategy consists of a long-term framework for Africa-EU cooperation. The current Roadmap[94] 2014-2017 working towards Peace and Security, Democracy, Good Governance and Human Rights, Human development, Sustainable and inclusive development and growth and continental integration, and Global and emerging issues was adopted at the 4th EU-Africa Summit in Brussels.

Tuning Africa[95] is part of the Africa-EU Partnership, it is a network of communities of academic experts that come together to discuss, design and elaborate learning instruments and share the results. The participants discuss a discipline or theme and share knowledge and experiences. The first phase (2011 – 2013) included 60 universities and included groups working on mechanical engineering and civil engineering (as well as medicine, teacher education, agricultural sciences). The second phase of Tuning Africa (2015 – 2018), set out in relation to the 2014-2017 Roadmap, includes a broader set of working groups and will work on implementing curriculum design at participating universities. The focus of tuning is on the following:[96]

- Designing curricula/degrees
- Implementing degree programmes at both undergraduate/postgraduate level
- Estimate student workloads and define credits

A list of subject specific competences for mechanical engineering and civil engineering groups is available on the Tuning Africa website[97] (e.g. "Skills in planning and executing mechanical engineering projects"). The following countries participated in the 2011-2013 implementation phase Tuning seminars:[98] Algeria, Benin, Botswana, Burundi, Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Egypt, Ethiopia, Gabon, Ghana, Ivory Coast, Kenya, Madagascar, Malawi, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Somalia, South Africa,

[93] http://tuningafrica.org/en/the-africa-eu-partnership

[94] http://www.africa-eu-partnership.org/sites/default/files/documents/2014_04_01_4th_eu-africa_summit_roadmap_en.pdf

[95] http://tuningafrica.org/en/what-is-tuning-africa

[96] ibid

[97] http://tuningacademy.org/civil-engineering-tuning-africa-implementation/?lang=en and http://tuningacademy.org/mechanical-engineering-tuning-africa-implementation/?lang=en

[98] http://tuningacademy.org/tuning-africa-implementation/?lang=en

South Sudan, Tanzania, Tunisia, Uganda, Zambia, Zimbabwe, and the Netherlands and Spain. Burundi, Malawi, Ethiopia, Cameroon, Kenya, Algeria, South Africa, Senegal, and Ghana participated in the feasibility study (2010-2011).[99]

1.2.1.3 Association of African Universities

The Association of African Universities (AAU)[100] was founded in 1967 and has headquarters in Ghana. AAU has 361 members, which are all higher education and research institutions. The objectives of the AAU are to:[101]

- To promote cooperation among higher education institutions in Africa
- Collect, classify and disseminate information on higher education and research, particularly in Africa
- Facilitate cooperation between its members and the international academic world
- Study, publicise and advocate the education and other related needs of African higher education institutions
- Facilitate the exchange of information and experience among members of the academic community, and promote best practice

1.2.1.4 African Network of Scientific and Technological Institutions

The Pan-African organisation, African Network of Scientific and Technological Institutions[102] (ANTSI) was set up in 1980 by UNESCO with funding from United Nations Development Programme (UNDP) and the German Government. It was established with the main objective to help African Universities and research organisations engaged in training and research in science and technology to contribute more effectively to the application of science and technology to development in Africa. ANTSI facilitates collaboration among African Scientific Institutions for the purposes of training and research in science, engineering and technology.

Figure 21 Overview of the locations of ANTSI institutions in Africa

Source: Based on data from ANTSI http://www.ansti.org/index.php/about-us/ansti-profile

[99] http://tuningacademy.org/tuning-africa-feasibility-study/?lang=en

[100] http://www.aau.org/membership/

[101] http://www.aau.org/page/vision-mission-goals

[102] http://www.ansti.org/index.php/about-us/ansti-profile

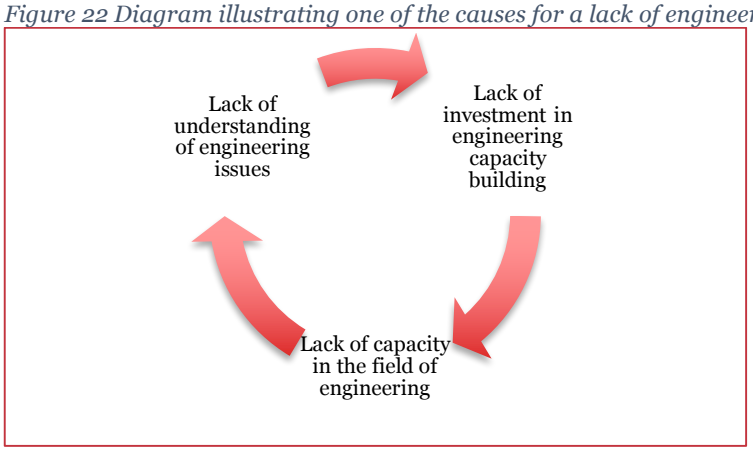
1.3 Challenges with building engineering capacity in SSA

As part of the Science, Technology and Innovation Strategy for Africa 2024, Sub-Saharan African countries have introduced policies for building ST&I and acknowledge the importance of building engineering capacity to develop ST&I. Several countries have also strategic technology/knowledge transfer plans with a focus on engineering (e.g. see the deep dive case on Ethiopia below). Policies and strategic programmes aim to overcome some of the challenges associated with building ST&I and engineering capacity.

There are a number of underlying framework conditions that impede the development of engineering capacity. Causes for the low capacity in engineering in SSA include:[103]

- Lack of economic development – as proxied by GDP per capita and GDP per capita growth
- Lack of infrastructure development, e.g. including access to internet
- Low levels of public investment in education, including STEM/engineering education as well as engineering institutions
- Low enrolment rates in secondary and tertiary education, including in STEM/engineering programmes
- Relatively low percentage of graduates from STEM/engineering programmes
- Low levels of public investment in research projects related to engineering
- Poor understanding of engineering issues amongst policy makers (amongst others)[104], which leads to a continued underinvestment in the field – this is illustrated by means of Figure 22.

Figure 22 Diagram illustrating one of the causes for a lack of engineering capacity in SSA



Altogether, countries that have more favourable framework conditions are in a better position to achieve sustained human capital development, enhance professional and technical competencies, promote of entrepreneurship and innovation, and achieve (higher) strategic private sector growth. The next sections explore the variations across Sub-Saharan African countries and regions. For example, the indicators illustrate that, in West SSA, the framework conditions in Ghana, Cabo Verde and Cote d'Ivoire are relatively favourable (of course Cabo Verde has a small population). We also present an overview of the countries/institutions that are in a better position to build capacity.

[103] See also the literature of the RAEng Engineers for Africa Identifying engineering capacity needs in Sub-Saharan Africa Supporting document 1: Literature review. http://www.raeng.org.uk/publications/other/engineers-for-africa-literature-review

[104] http://www.raeng.org.uk/publications/reports/engineers-for-africa

Table 8 Deep dive into Ethiopia

Ethiopia's growth strategy is defined as an Agricultural-Development-Led Industrialisation (ADLI). The strategy is supplemented by sector-specific strategies, e.g. health, education, ICT, population, industry.[105] In terms of education, the view is to stimulate human resource development focussing on engineering, technology and natural sciences, "by introducing high quality science and mathematics curricula at primary and secondary schools and the recently adopted policy of the 70:30 university intake ratio in favour of science & technology".[106] In May 2016, the Growth and Transformation Plan II (GTP II) for 2015/16-2019/20 of the Federal Democratic Republic of Ethiopia set the objectives for reform including reform in the higher education sector. The plan was published by the Ministry of Finance and Economic Development. Amongst other, the plan defines that "training programs will focus on science and technology fields and its quality will be improved in efficiency to bring them on par with similar institutions in other countries. Special support will be given to science and technology universities and selected technology institutions". This growth plan builds on the first Growth and Transformation Plan (GTP) which included the following objectives:[107]

- Establish and implement a coordinated and integrated general governance framework for building STI capacity
- Establish and implement an appropriate national Technology
- Capability Accumulation and Transfer (TeCAT) system
- Promote research that is geared towards technology learning and adaptation
- Develop, promote and commercialise useful indigenous knowledge and technologies
- Define the national science and technology landscape and strengthen linkages among the different actors in the national innovation system
- Ensure implementation of STI activities in coordination with other economic and social development programs and plans
- Create conducive environment to strengthen the role of the private sector in technology transfer activities sustainably

A review of the success under this growth plan concludes that "70 percent of undergraduate students were enrolled in Science and Technology program and 40 percent of them were enrolled in engineering and technology program". Enrolment rates are in line with the policy objective of the government, but in order to improve the quality of education it is decided that the on-going higher education quality improvement program needs to be fully implemented and higher education and training systems need to be linked with development activities, to keep up with technology development. As part of Science and Technology development, the plan is to create a technological transfer framework. Several implementation strategies have been outlined and in addition, the plan aims to support science and technology incubation institutions in the universities.

In 2013, the Federal Democratic Republic of Ethiopia prepared a science, technology and innovation policy focusing on building the technology capacities of medium and higher manufacturing and service enterprises and embarked on activities. Among the 11 highly important issues included in the Science, Technology and Innovation Policy is the linkage of universities, technical and vocational training institutions, research institutions and the industry. The procedural Directive for the linkage of Education and Training, Research Institutions and the Industry no. 3/2013[108] is key to the implementation. The major objectives of this procedural directive are to put in place the frameworks in which the major actors of the linkage will engage collaboratively, to create an organisational structure to coordinate, lead with integration and monitor created in the respective economic Zones; to outline the activities to be carried out by the linkage and the respective responsibilities and functions of the actors. The objectives of the linkage are:

- Ensuring that the procedures through which practical trainings are given to teachers and students in manufacturing and service provision enterprises are in the spirit of cooperation, with appropriate plans and according to procedures
- Facilitation of research and technology transfer activities to be operated based upon the need of solving problems related to competitiveness of the industry
- Improving the roles and capacities of education and training as well as research institutions such that intellectuals develop the ability to consult manufacturing facilities and service providers
- Developing the culture of joint planning and operation among education and training institutions, research entities and the industry by bringing together their resources
- Improving the capacities of the actors of the linkages to implement education and training, research, consultancy and technology transfer

[105] http://www.engineeringethiopia.org/sites/iot.newthinking.de/files/u482/ESDP%20IV.pdf The Federal Democratic Republic of Ethiopia (2010). Education Sector Development Program IV (ESDP IV) 2010/2011 – 2014/201. 2003 EC – 2007 EC Program Action Plan.

[106] http://www.engineeringethiopia.org/sites/iot.newthinking.de/files/u482/ESDP%20IV.pdf The Federal Democratic Republic of Ethiopia (2016). Growth and Transformation Plan II (GTP II)

[107] The Federal Democratic Republic of Ethiopia Science and Technology and Innovation policy (2012).

http://www.engineeringethiopia.org/sites/iot.newthinking.de/files/u482/STI%20Policy.pdf

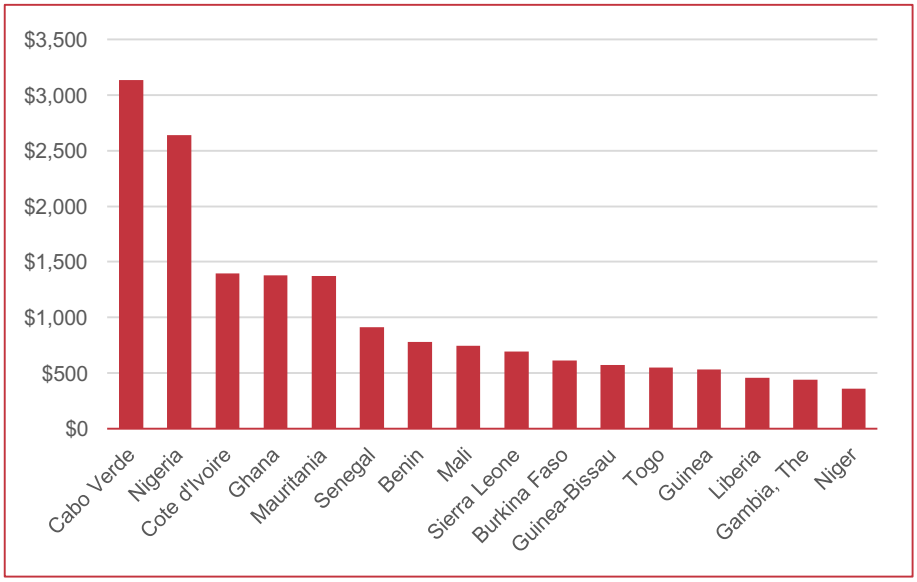
[108] The Federal Democratic Republic of Ethiopia (2013). Procedural Directive for the linkage of Education and Training, Research Institutions and the Industry no. 3/2013.
http://iot.newthinking.de/sites/iot.newthinking.de/files/u482/National%20UILGuideline.pdf

2 West SSA

2.1 Key economic framework conditions

GDP per capita in West SSA ranges from around $3,100 in Cabo Verde to around £350 in Niger. The average GDP per capita in West SSA is just over $1,000, which is close to half of the average GDP per capita in SSA ($2,200).

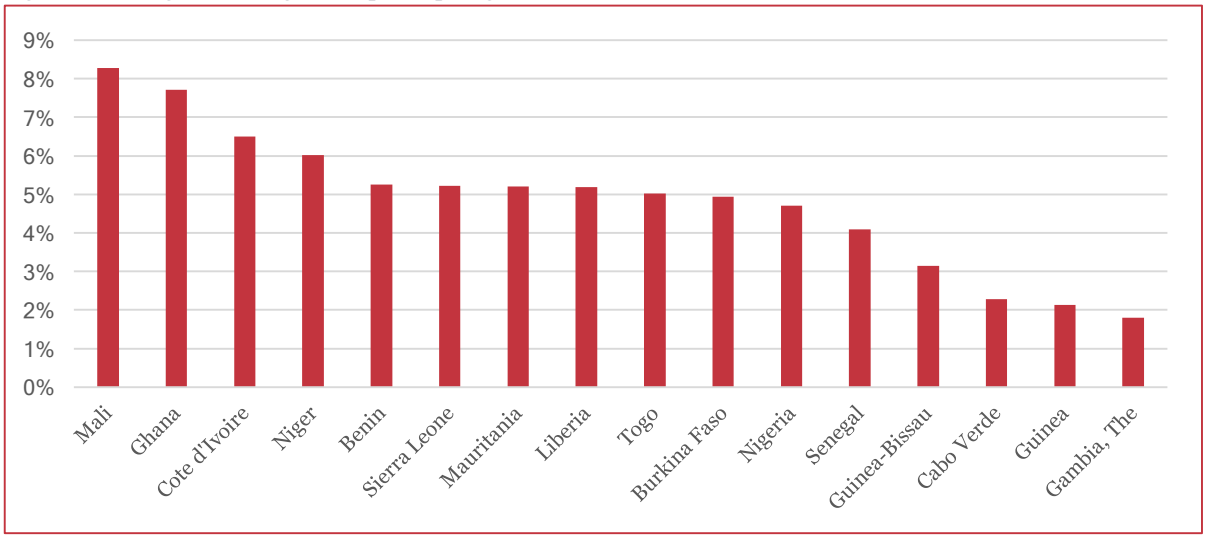
Figure 23 GDP per capita – West SSA



Source: Data on GDP (current $US) from World Bank national accounts data, and OECD National Accounts data files. Population statistics from United Nations World Population Prospects. Data for Gambia and Mauritania are from 2014. All other data from 2015.

Five-year average growth rates in West SSA range from just over 8% in Mali to close to 2% in Gambia. The five-year average growth rate is 4.8%, which is slightly above the five-year average growth rates in SSA (4.3%).

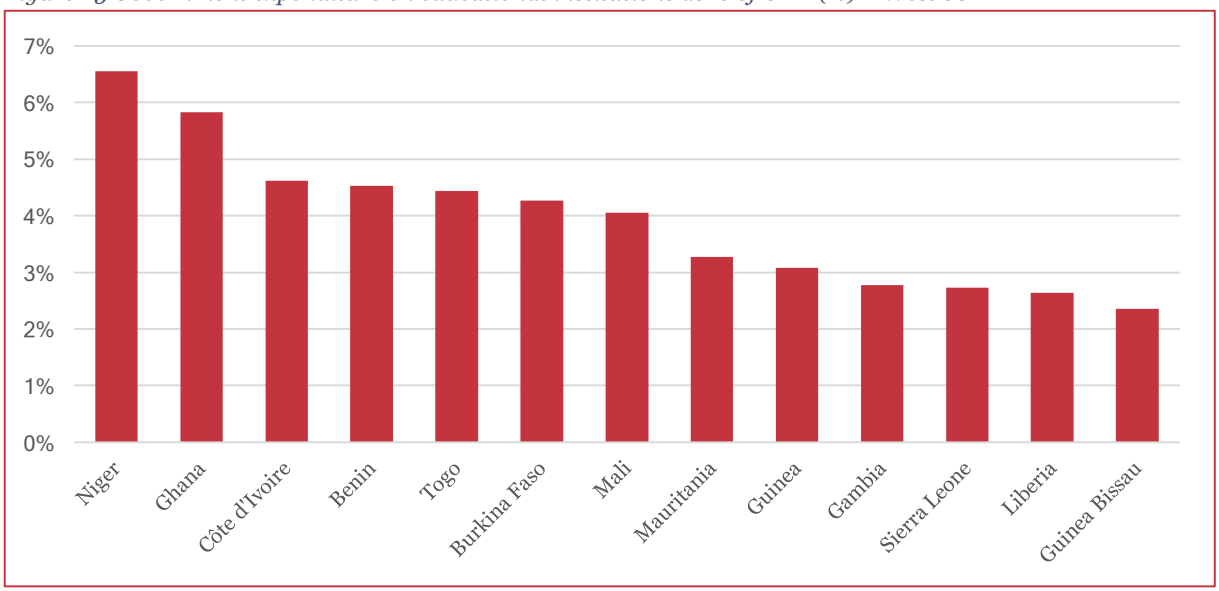
Figure 24 Five year average GDP per capita growth – West SSA



Source: World Bank national accounts data, and OECD National Accounts data files, 2011-2015. Missing data for 2015 for Gambia and Mauritania.

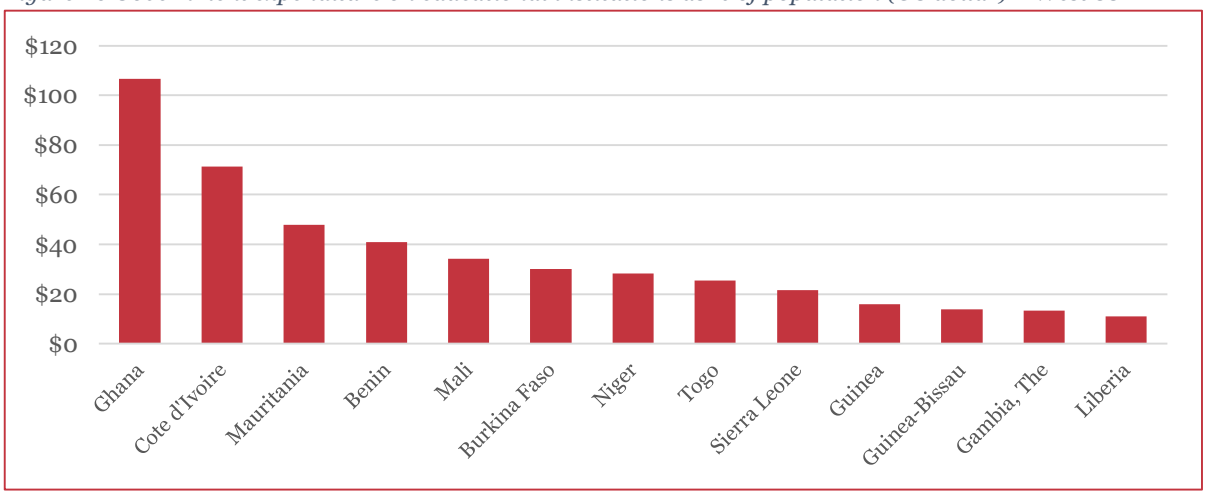
Government expenditure on educational institutions as a percentage of GDP varies across the region and ranges from 7% in Niger to 2% in Guinea Bissau – see figure below. Expenditure as a percentage of population in the region ranges from above $100 per person in Ghana to around $10 per person in Liberia. Expenditure in Niger, as a percentage of the population is $28, below the regional average of $35. Government expenditure on educational institutions is relatively low in term of percentage of GDP and percentage of population in countries such as Liberia, Gambia, Guinea-Bissau, Guinea, and Sierra Leone and expenditure is relatively high in Cote d'Ivoire and Ghana.

Figure 25 Government expenditure on educational institutions as % of GDP (%) – West SSA



Source: Data from Education statistics, World bank, UNESCO. Data from latest year available (2014, 2013, or 2012 – See table in Appendix) – missing data for Cabo Verde, Nigeria and Senegal

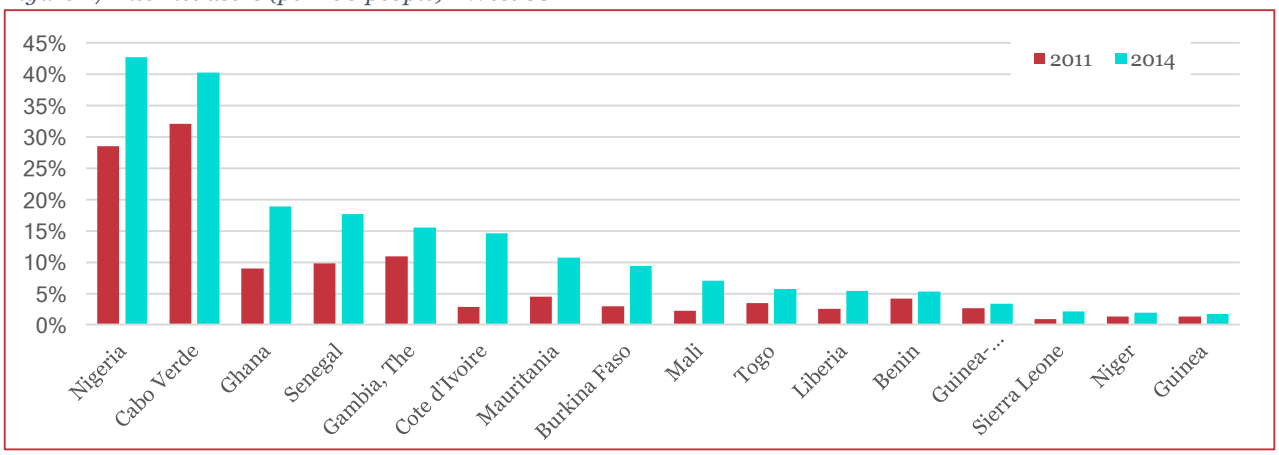
Figure 26 Government expenditure on educational institutions as % of population (US dollar) – West SSA



Source: Data from Education statistics, World bank, UNESCO. Data from latest year available (2014, 2013, or 2012 – See table in Appendix) – missing data for Cabo Verde, Nigeria and Senegal. Data on GDP (current $US) from World Bank national accounts data, and OECD National Accounts data files. Population statistics from United Nations World Population Prospects.

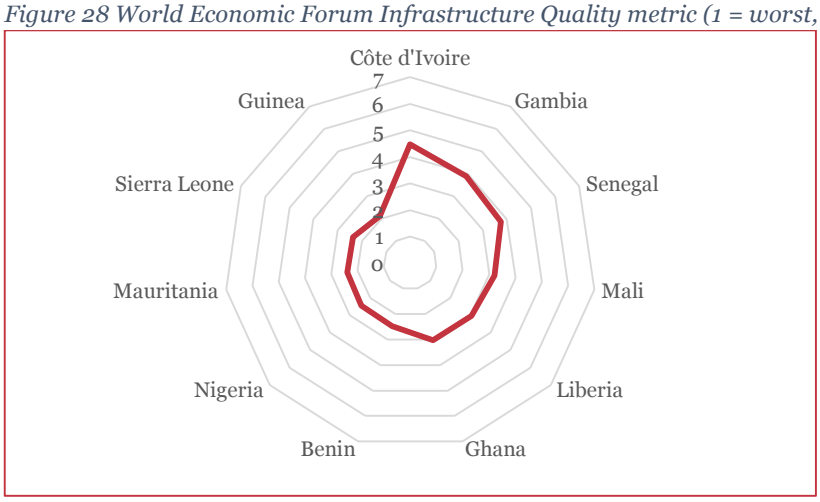
The percentage of population using the internet has risen rapidly in the past few years in SSA from 10% in 2011 to 15% in 2014. In West SSA internet use increased from 7% on average in 2011 to 13% on average in 2014. Countries with the highest percentage of population using the internet are Nigeria – 43% - and Cabo Verde - 40% - in 2014. The countries in West SSA that score highest on the WEF composite infrastructure indicator are Cote d'Ivoire, Gambia and Senegal – see Figure 28.

Figure 27 Internet users (per 100 people) - West SSA



Source: International Telecommunication Union, World Telecommunication/ICT Development Report and database, and World Bank estimates

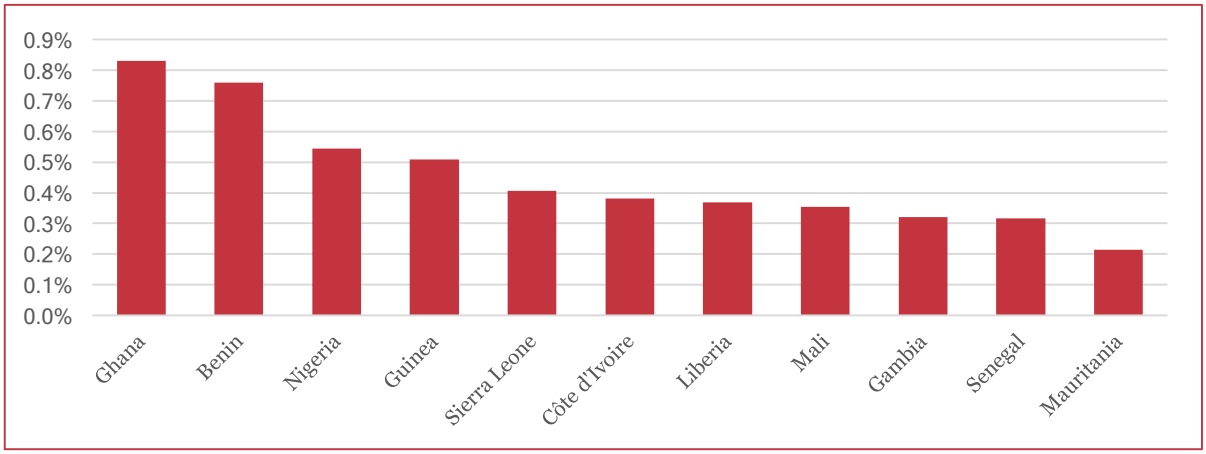
Figure 28 World Economic Forum Infrastructure Quality metric (1 = worst, 7 = best). – West SSA



Data from CEBR, 2016. Data missing for Cabo Verde, Burkina Faso, Togo, Guinea-Bissau, and Niger.

The number of employed engineers as a percentage of the total population is highest in Ghana and Benin (around 0.8%), it is lowest in Mauritania (around 0.2%) – see Figure 29.

Figure 29 Employed engineers as a share of the total population – West SSA



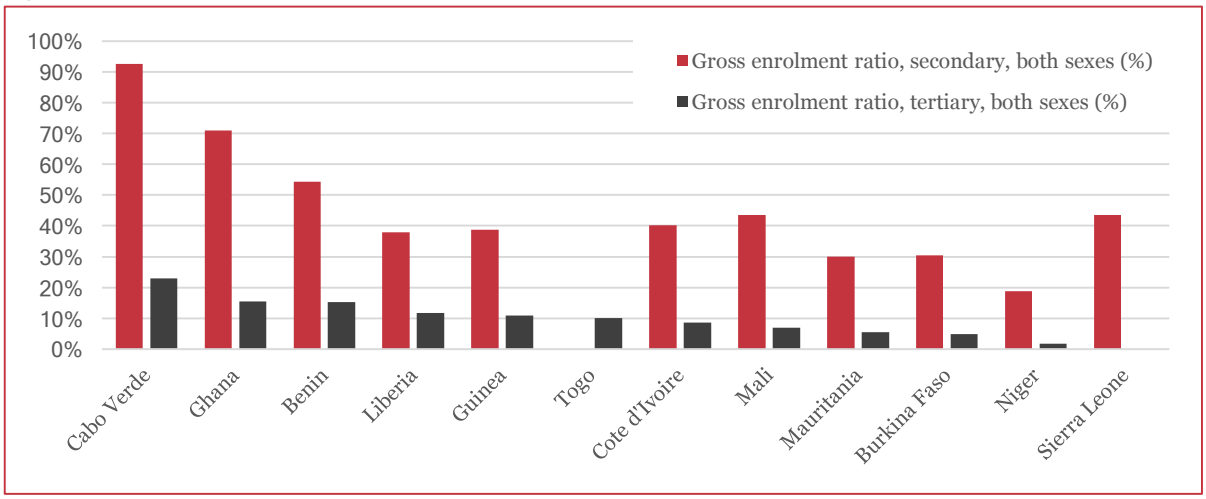
Data from Eurostat, ILO, Cebr analysis, CEBR, 2016. Data missing for Cabo Verde, Burkina Faso, Togo, Guinea-Bissau, and Niger.

2.2 Key human capital development framework conditions

In West SSA gross enrolment rates in secondary education ranges from 93% in Cabo Verde to 19% in Niger (average enrolment in SSA is 47%). Gross enrolment rates in tertiary education ranges from 23% in Cabo Verde to 2% in Niger (average enrolment in SSA is 7%).

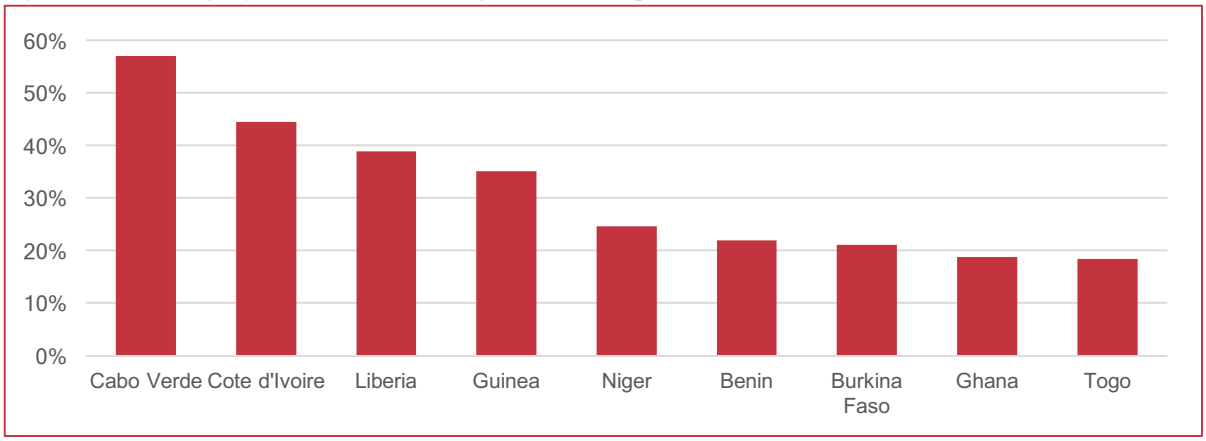
In West SSA, data on percentage of enrolment in tertiary education in private institutions is largely uncollected. However, based on data from 2012, In Cabo Verde, this percentage of enrolment was 57%, which is rather high, and in Togo the percentage was only 18%, see Figure 31.

Figure 30 Enrolment rates – West SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, 2013-2015. Missing data for Togo (enrolment rates, secondary only), Gambia, Guinea-Bissau, Nigeria, and Senegal.

Figure 31 Percentage of enrolment in tertiary education in private institutions (%) – West SSA



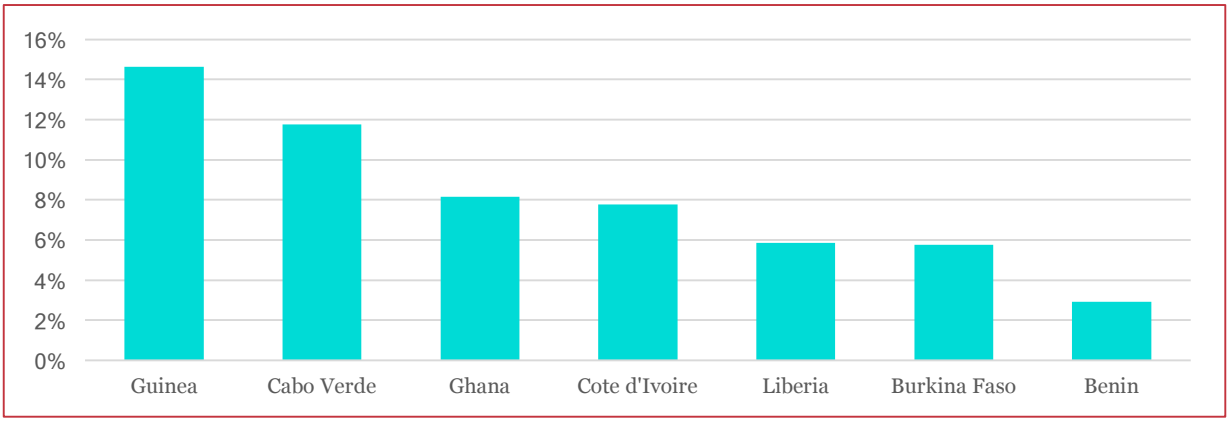
Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, 2012-2014. Missing data for Gambia, Guinea Bissau, Mali, Mauritania, Nigeria, Senegal, and Sierra Leone

There is limited data available on the percentage of graduates from tertiary education graduating from Science programmes. Based on the data available we find that the percentage of science graduates from Ghana are relatively high – 11%. The percentage of science graduates is relatively lower in Burkina Faso – 9% - and even lower in Liberia – 4% (data from Education statistics, World bank, UNESCO Institute for Statistics, 2012-2014 see appendix).

The average percentage of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes in West SSA is 8%, which is just below the average estimated for the whole of SSA (9%). The percentage of enrolment in the region is highest in Guinea - 15% - and is lowest in Benin – 3%. Ghana, Guinea, and Cote d'Ivoire have substantial student populations' enrolled in tertiary

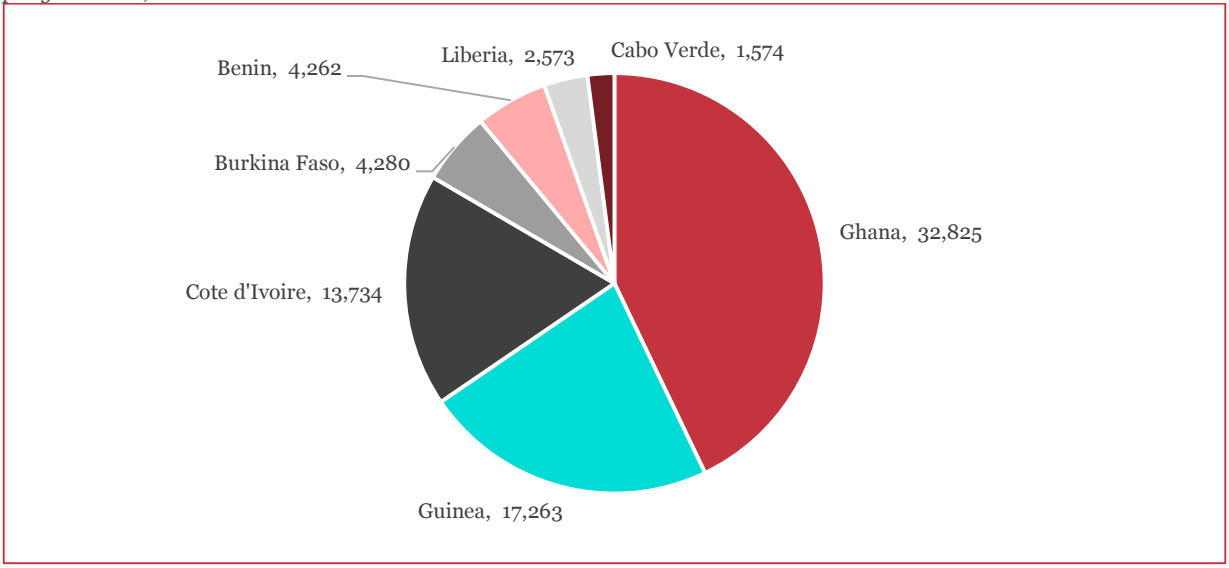
Engineering, Manufacturing and Construction programmes, respectively around 33,000 17,000 and 14,000 – see Figure 33.

Figure 32 Percentage of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, both sexes (%) West SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, includes data from 2012-2014. Missing data for Gambia, Guinea Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

Figure 33 Number of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, both sexes. West SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, includes data from 2012-2014. Missing data for Gambia, Guinea Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

2.3 Key stakeholders

2.3.1 Regional organisations and engineering organisations

Ghana, Nigeria, Sierra Leone, Cote d'Ivoire, Burkina Faso, Benin, Togo and Gambia are members of WAFEO/ FAEO. FAEO is an international organisation that represents the engineering profession and was founded in 1968 with support from UNESCO.

Benin, Burkina Faso, Cape Verde, Cote d' Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal and Togo are member of Economic Community of West

African States (ECOWAS)[109]. ECOWAS was established in 1975 and is a trading union promoting economic cooperation and integration. Mauritania is not a member of ECOWAS.

2.3.2 Higher education and research institutions

Table 9 presents an overview of the top 10 universities located in West SSA. This top ten are located in Nigeria, Ghana and Senegal.[110]

Table 9 Top 10 HEIs in West SSA

Country	Africa Rank	World rank	HEI
Nigeria	19	1366	University of Ibadan
Ghana	22	1639	University of Ghana
Nigeria	25	1723	Covenant University Ota
Nigeria	32	2038	Obafemi Awolowo University
Ghana	35	2083	Kwame Nkrumah University of Science & Technology
Nigeria	47	2257	University of Lagos
Nigeria	51	2437	University of Nigeria
Nigeria	56	2607	University of Ilorin
Senegal	57	2616	Université Cheikh Anta Diop de Dakar
Nigeria	59	2670	University of Agriculture Abeokuta

Source: http://www.webometrics.info/en/Africa

2.3.3 Engineering associations

Ghana, Nigeria, Sierra Leone, Cote d'Ivoire, Burkina Faso, Benin, Togo, and Gambia are members of the West African Federation of African Engineering Associations (WAFEO).[111] Examples of other engineering associations are presented in the table below.

Table 10 Examples of engineering associations – West SSA

Country	Engineering association	Members	Objectives and Services
Burkina Faso	Association Des Ingenieurs Et Techniciens En Civil Du Burkina		
Cabo Verde	Order of Engineers (OECV)[112]	Individuals	
Côte d'Ivoire	Federation of Ivorian Engineering Organisations FIACI		
Gambia			
Ghana	The Ghana Institution of Engineers[113] (GhIE)	Firms and students	Objectives include: Promoting Engineering Excellence for Society, Be leaders in the development of Science, Engineering and Technology at all levels of Society, Share knowledge[114] To

[109] http://www.ecowas.int/about-ecowas/basic-information/
[110] http://www.webometrics.info/en/Africa
[111] http://faeo.org/index.php/en/members, see also http://www.wfeo.org/?post_type=organizations&s=&continent=africa
[112] http://www.oecv.cv/
[113] http://www.ghie.org.gh/
[114] http://www.ghie.org.gh/

Country	Engineering association	Members	Objectives and Services
			advance the science and profession of engineering to the benefit of society; To establish and manage a register of all engineering disciplines qualified to practice in Ghana.
Ghana	Ghana Association of Consultants[115]	Companies	
Guinea			
Guinea Bissau			
Liberia	Liberia Institution of Engineers LIE		
Mali	Association of Women Engineers (AFIMA)[116]	Individuals	Promote the advancement of women engineer by training, development and information campaigns; encourage girls to move in the technical branches, arouse the spirit and solidarity between Member; convince the public and especially the employers that the job Engineer may be validly exercised by both a man by a woman; contribute to socio-economic development of rural women; engineers encourage women to participate in the constitution of a social model, showing that they are able to juggle an active professional life and family balance; encourage and develop women engineers will make career.
Mauritania			
Niger			
Nigeria	Council for the Regulation of Engineering in Nigeria[117] (COREN)[118]	Engineering personal and firms (30,000 members)	The Council for the Regulation of Engineering in Nigeria, COREN, is a body set-up by the Decrees 55/70 and 27/92 (now Acts 110). The Decrees empowered the Council to regulate and control the training and practice of engineering in Nigeria and to ensure and enforce the registration of all engineering personnel (i.e. Engineers, Engineering Technologists, Engineering Technicians, and Engineering Craftsmen) and consulting firms wishing to practice or engage in the practice of engineering.
Nigeria	The Nigerian Society of Engineers (NSE)[119]	Fellow, affiliates, corporate members, graduates, associates, and students	The Nigerian Society of Engineers is the umbrella organization for the Engineering Profession in Nigeria. The Society looks after the professional needs of members through well structured programmes and regular interactions among the different cadre of membership, enhancing high professional standard and ethical practices.
Nigeria	Nigerian Academy of Engineering (NAE)[120]	Individuals	Mission: To provide input and leadership in national technological issues and policies at the highest level possible, through contributions to Science Engineering and Technology Ideas in Nigeria and, by extension, globally.
Nigeria	Association of Consulting Engineers, Nigeria (ACEN)[121]	Companies	The focus of this effort is to ensure that the highest level of technical competence and business ethics are brought to bear on the practice of the profession in Nigeria.

[115] http://www.ghanaconsultants.org/
[116] http://www.afima.over-blog.com/
[117] http://www.nse.org.ng/about-nse/history-of-nse
[118] http://www.coren.gov.ng/
[119] http://www.coren.gov.ng/about-coren/coren-history
[120] http://www.nae.org.ng/
[121] www.acen.org.ng

Country	Engineering association	Members	Objectives and Services
Senegal	Senegalese Union of Engineering Organisations (SUEO)		
Sierra Leone	The Sierra Leone Institution of Engineers (SLIE) [122]	Graduates or practicing engineers	Facilitating the advancement of Engineering in all its branches for the improvement and development of Sierra Leone. Promoting and maintaining the Unity, Public usefulness, honour and interest of its members. Promoting sound Engineering Practice, Engineering Education in schools and Gender Participation in Engineering. Advising Government on all Engineering Matters.
Togo			

2.3.4 Employer associations and major employers

Out of the 16 West SSA countries, 12 have employment organisations that are member of the International Organisation of Employers (IOE) – see Table 11. For example, in Nigeria, NECA is an umbrella organisation of employers in the Organised Private Sector of Nigeria that was launched in 1957. "NECA provides a platform for private sector employers to interact with the government, labour, communities and other relevant institutions in and outside Nigeria for the purpose of promoting harmonious business environment that will engender productivity and prosperity for the benefit of all".[123]

Table 11 Overview of employer organisations that are member of the International Organisation of Employers – West SSA

Country	Sector
Benin	Conseil National du Patronat du Bénin (CNP-Bénin)
Burkina Faso	Conseil national du Patronat Burkinabé (CNPB)
Cabo Verde	Association Commerciale, Industrielle et Agricole de Barlavento (ACIAB) Association Commerciale de Sotavento du Cap Vert (ACS)
Côte d'Ivoire	Confédération générale des entreprises de Côte d'Ivoire (CGECI)
Gambia	
Ghana	Ghana Employers' Association (GEA)
Guinea	Conseil National du Patronat Guinéen (CNPG)
Guinea Bissau	
Liberia	
Mali	Conseil National du Patronat du Mali (CNPM)
Mauritania	Union Nationale du Patronat de Mauritanie
Niger	Conseil National du Patronat Nigerien (CNPN)
Nigeria	Nigeria Employers' Consultative Association (NECA)
Senegal	Conseil National du Patronat du Sénégal (CNP)
Sierra Leone	

[122] http://slie-sl.org/

[123] http://www.neca.org.ng/index.php/about-neca/who-we-are

Country	Sector
Togo	Conseil National du Patronat du Togo (CNP)

Source: http://www.ioe-emp.org/ioe-members/

In West SSA there are 13 companies that are in the top 250 Africa Businesses ranking[124] that are active in sectors related to engineering. Eight of these are located in Nigeria – see Table 12. A number of these firms are active in the agri-business which is one of the priority sectors.

Table 12 Overview of African companies in the top 500 active in engineering related sectors – West SSA

Country	Sector	Company	Turnover ($k)
Cote d'Ivoire	AGRIBUSINESS	SIFCA	997,135
Cote d'Ivoire	AGRIBUSINESS	CARGILL WEST AFRICA	629,701
Ghana	AGRIBUSINESS	PRODUCE BUYING COMPANY	786,026
Ghana	TELECOMS	MTN GHANA	729,674
Nigeria	TELECOMS	MTN NIGERIA	4,283,839
Nigeria	AGRIBUSINESS	FLOUR MILLS OF NIGERIA	1,572,852
Nigeria	CONST. MATERIALS	DANGOTE CEMENT	1,436,722
Nigeria	TELECOMS	AIRTEL NIGERIA	1,229,400
Nigeria	CONSTRUCTION	JULIUS BERGER NIGERIA	1,031,725
Nigeria	AGRIBUSINESS	DANGOTE SUGAR REFINERY	648,646
Nigeria	AGRIBUSINESS	OLAM NIGERIA*	611,020
Nigeria	AGRIBUSINESS	NESTL NIGERIA	596,582
Senegal	TELECOMS	SONATEL	1,226,247

Source: http://www.theafricareport.com/top-500-companies-in-africa-2013.html

2.3.5 *National policy makers / agencies, research councils and founding bodies*

The ministries that contribute to shaping education and research include ministries of education and ministries of science and technology. These include, for example:

- Sierra Leone - Ministry of Education, Science and Technology
- Ghana - Ministry of Education and the Ministry of Environment, Science, Technology and Innovation
- Nigeria - Federal Ministry of Education, Minister of Science and Technology and the Rivers State Ministry of Education

2.4 International schemes and initiatives focusing on West SSA

The following countries are part of the Africa-EU partnership – Tuning Africa[125]:

- Benin
  - Abomey-Calavi University
  - Université Catholique de l'Afrique de l'Oueste, UCAO-UUC

[124] http://www.theafricareport.com/top-500-companies-in-africa-2013.html

[125] http://tuningafrica.org/en/participating-countries/

- Burkina Faso
  - International Institute for Water and Environmental Engineering
  - Université Ouaga II
- Cabo Verde
  - ISCEE - Instituto Superior de Ciências Económicas e Empresariais
  - Universidade Jean Piaget de Cabo Verde
- Cote d'Ivoire
  - Université Alassane Ouattara
  - Université des Sciences et Technologies de Côte d'Ivoire
  - University of Nangui Abrogoua

  Gambia
  - University of the Gambia
- Ghana
  - Universidad Kwame Nkrumah de Ciencia y Tecnología
  - University of Ghana
  - University of Professional Studies
- Mali
  - Universite des Sciences, des Techniques et Technologies de Bamako
- Mauritania
  - Université des Sciences, de Technologie et de Médecine
- Nigeria
  - Ahmadu Bello University
  - Benue State University
  - Ebonyi State University
  - Federal University of Agriculture
  - National Open University of Nigeria
  - Nnamdi Azikiwe University
  - University of Calabar
  - University of Ibadan
  - University of Ilorin
  - University of Nigeria, Nsukka
- Senegal
  - Université de Thiès
  - University Gaston Berger
  - 'Université Cheikh Anta DIOP

An example of a research project funded by USAID, Partnership for Enhanced Engagement in Research (PEER) (2014-2016) in Ghana, Kwame Nkrumah University of Science & Technology, is the project

PRESSA: Photovoltaic Reliability Evaluation in Sub-Sahara Africa, in collaboration with Arizona State University (ASU)[126].

The following are winners of the 2015-2016 RAEng Africa Prize for Engineering Innovation[127]

- Ghana: Mechanical cassava harvester

  "Cassava is a food crop that grows underground across Sub-Saharan Africa. It is eaten by more than 800 million people globally, and also used as a biofuel. The labour intensive harvesting of cassava is the biggest constraint to its commercial production. The mechanical cassava harvester is an affordable tractor-mounted implement which turns up the soil to expose the root vegetable without damaging it. It takes five to ten minutes to harvest one cassava plant manually, depending on the softness of the soil. The mechanical harvester can uproot one plant every second".

- Burkina Faso: FasoPro

  "FasoPro is a social venture that makes nutritional products from Shea caterpillars. It is based in Burkina Faso, where half the population live below the poverty line. The shea tree is known for its nuts, which are used in foods and cosmetics. The 'chitoumou' caterpillars which feed on the tree are traditionally harvested for three months of the year as a high-protein food rich in Omega 3. FasoPro has developed a breeding system to ensure a year-round supply of the caterpillars, which it processes into a powdered meal supplement to combat malnutrition. FasoPro products also help to protect shea trees by making communities more aware of their value".

- Nigeria: Tryctor

  "The Tryctor is a three-wheeled mini-tractor for small-scale farmers. It can also be used as a mobile generator. Using low-cost local components, it is affordable, easy to maintain, efficient and simple to operate. The three-wheeled Tryctor is manufactured in Nigeria and aimed at small farmers and cooperatives. Its size to power ratio makes it a multipurpose vehicle which can also be used to transport goods".

3 East SSA

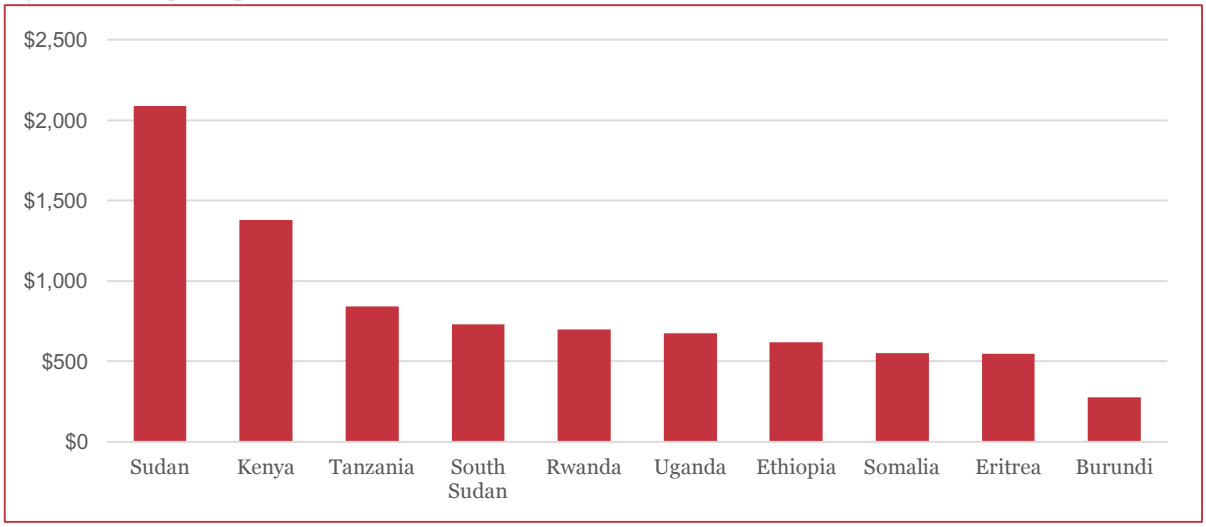
3.1 Key economic framework conditions

GDP per capita in East SSA ranges from around $2,000 in Sudan to around £275 in Burundi. The average GDP per capita in East SSA is approximately $840, which is less than half of the average GDP per capita in SSA (close to $2,200) but is higher than the median GDP per capita, which is $842 for SSA.

[126] http://sites.nationalacademies.org/PGA/PEER/PEERscience/PGA_152029

[127] http://www.raeng.org.uk/grants-and-prizes/international-research-and-collaborations/africa-prize/current-and-recent-awards

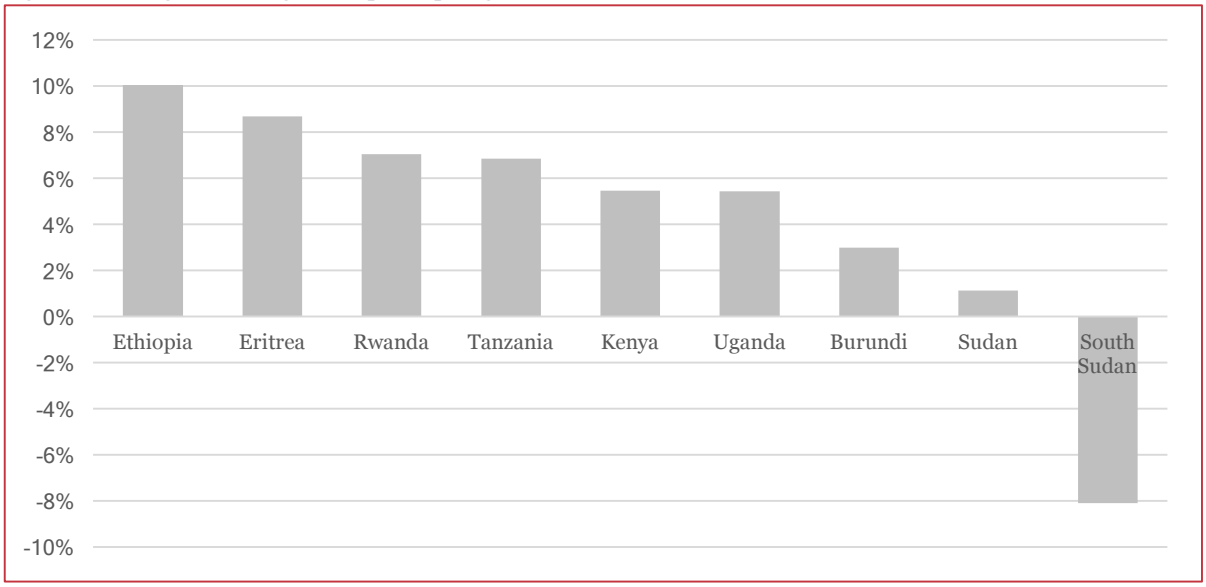
Figure 34 GDP per capita – East SSA



Source: Data on GDP (current $US) from World Bank national accounts data, and OECD National Accounts data files. Population statistics from United Nations World Population Prospects. Data Eritrea is from 2011. All other data from 2015

Five-year average growth rates in East SSA range from just over 10% in Ethiopia to negative 8% in South Sudan. The GDP growth rates in Ethiopia are the highest in SSA and have been steady over the past five years. The five-year average growth rate for the region is 3.7%, which is slightly above the five-year average growth rates in SSA (4.3%).

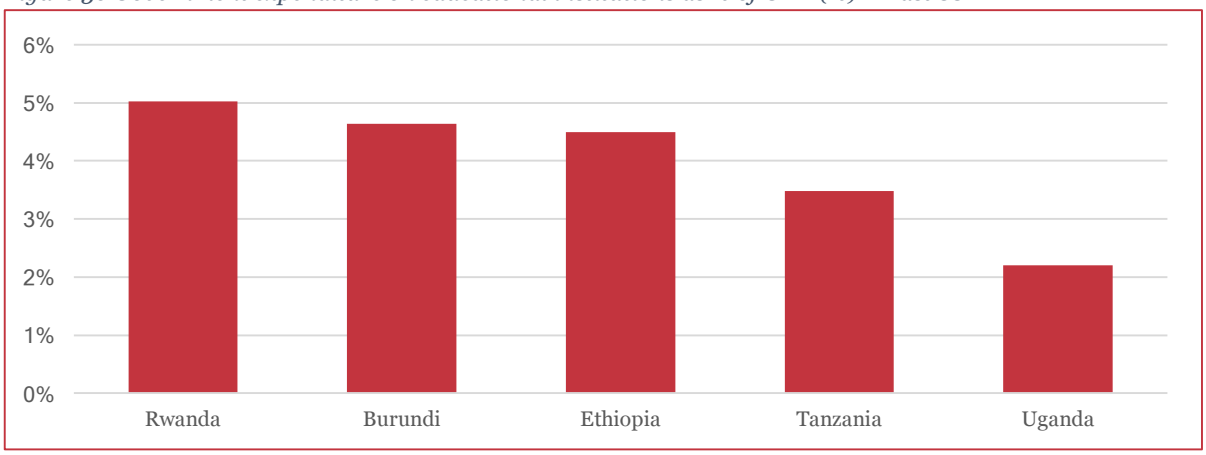
Figure 35 Five year average GDP per capita growth – East SSA



Source: World Bank national accounts data, and OECD National Accounts data files, 2011-2015. Data for Eritrea is from 2011 only. Missing data for Somalia.

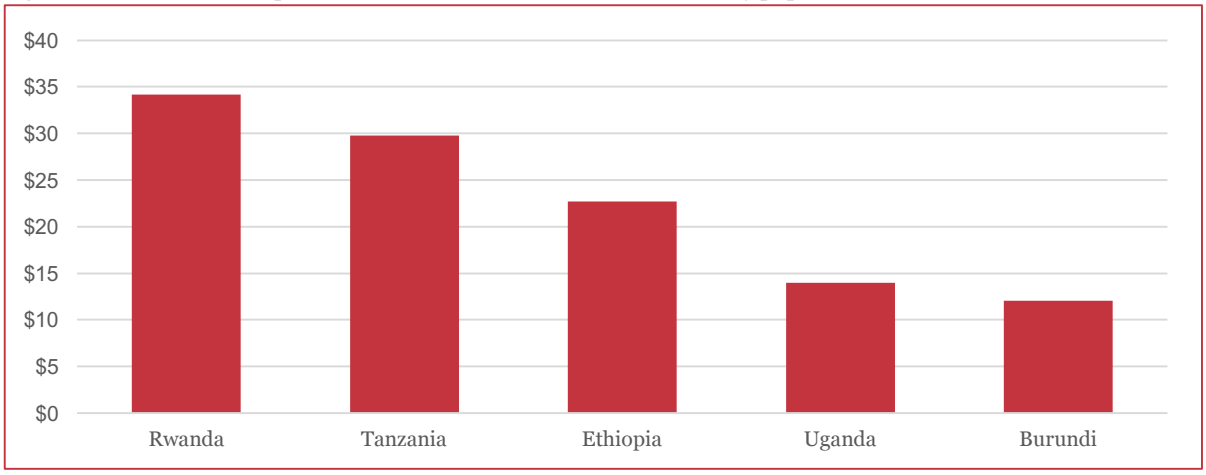
Government expenditure on educational institutions as a percentage of GDP varies moderately across the region and ranges from 5% in Rwanda to 2% in Uganda – see figure below. Expenditure as a percentage of population in the region ranges from around $34 per person in Rwanda to around $12 per person in Burundi. Expenditure in the region for all of the countries presented in Figure 37 falls below the average expenditure in SSA, which is just above $60.

Figure 36 Government expenditure on educational institutions as % of GDP (%) – East SSA



Source: Data from Education statistics, World bank, UNESCO. Data from latest year available (2014, 2013, or 2012 – See table in Appendix) – missing data for Sudan, South Sudan, Somalia, Kenya, and Eritrea.

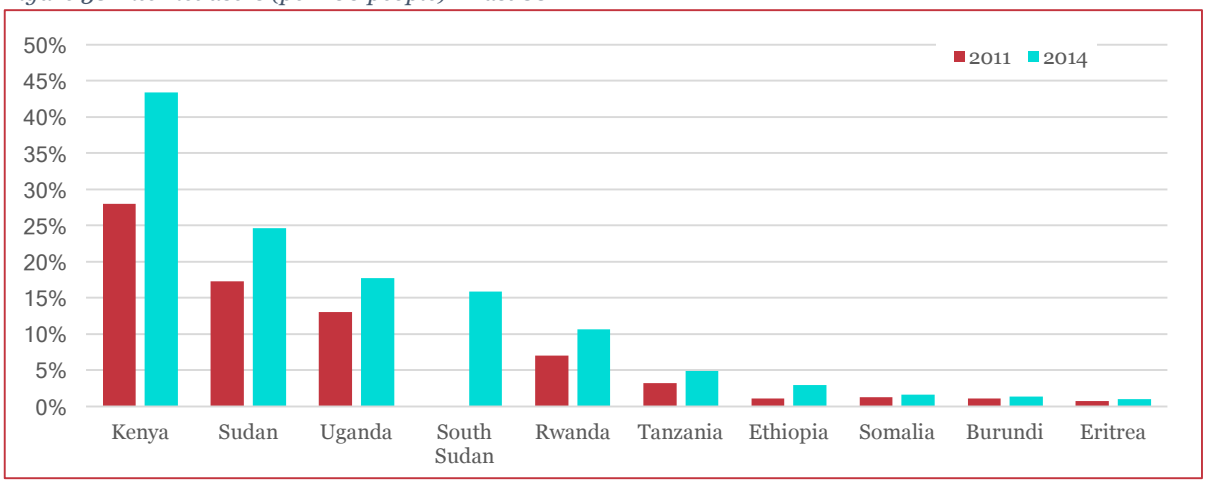
Figure 37 Government expenditure on educational institutions as % of population (US dollar) – East SSA



Source: Data from Education statistics, World bank, UNESCO. Data from latest year available (2014, 2013, or 2012 – See table in Appendix) – missing data for Sudan, South Sudan, Somalia, Kenya, and Eritrea. Data on GDP (current $US) from World Bank national accounts data, and OECD National Accounts data files. Population statistics from United Nations World Population Prospects.

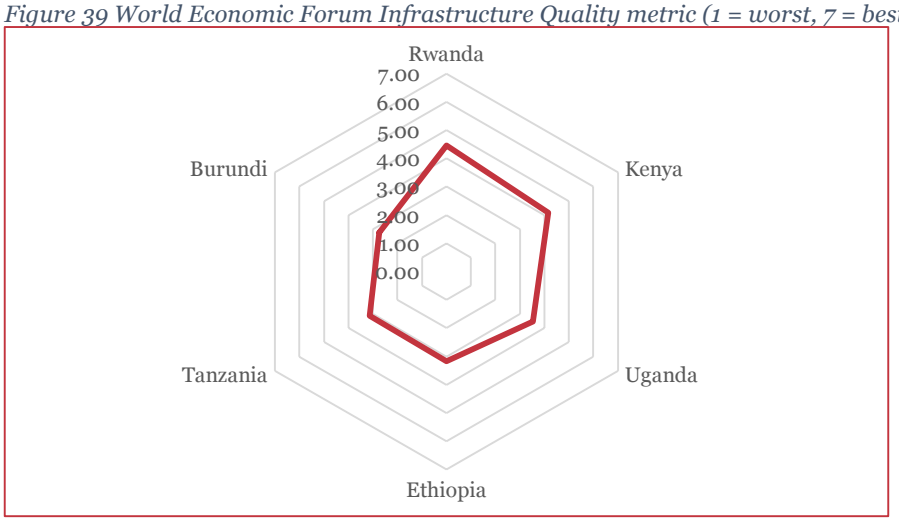
The percentage of population using the internet has risen rapidly in the past few years in SSA from 10% in 2011 to 15% in 2014. In East SSA internet use increased from 8% on average in 2011 to 12% on average in 2014. Countries with the highest percentage of population using the internet are Kenya – 43% - and Sudan - 25% - in 2014. The countries in East SSA that score highest on the WEF composite infrastructure indicator are Rwanda, Kenya and Uganda – see Figure 39.

Figure 38 Internet users (per 100 people) - East SSA



Source: International Telecommunication Union, World Telecommunication/ICT Development Report and database, and World Bank estimates

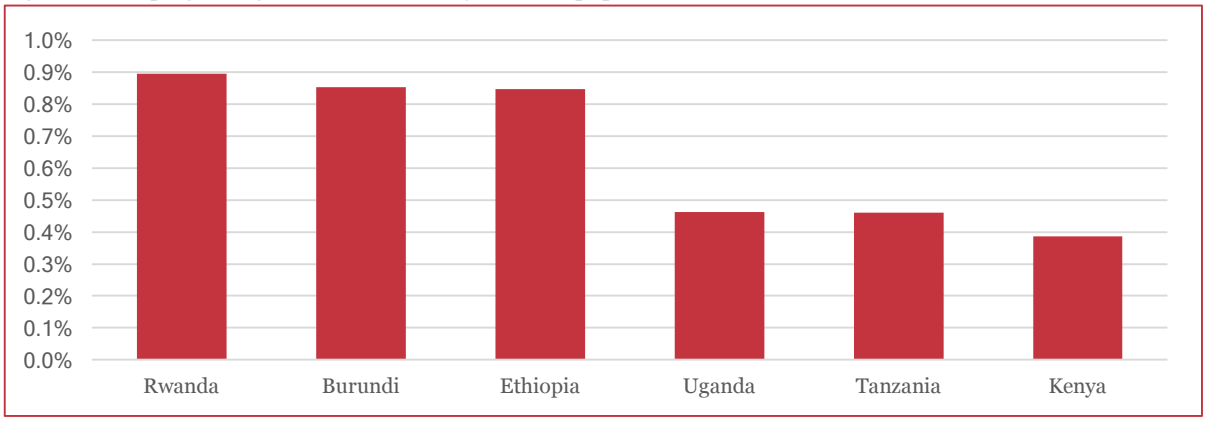
Figure 39 World Economic Forum Infrastructure Quality metric (1 = worst, 7 = best). –East SSA



Data from CEBR, 2016. Data missing for Sudan, South Sudan, Somalia, and Eritrea

The number of employed engineers as a percentage of the total population is highest in Rwanda, Burundi and Ethiopia (around 0.8%), it is lowest in Kenya (close to 0.4%) – see Figure 40.

Figure 40 Employed engineers as a share of the total population – East SSA



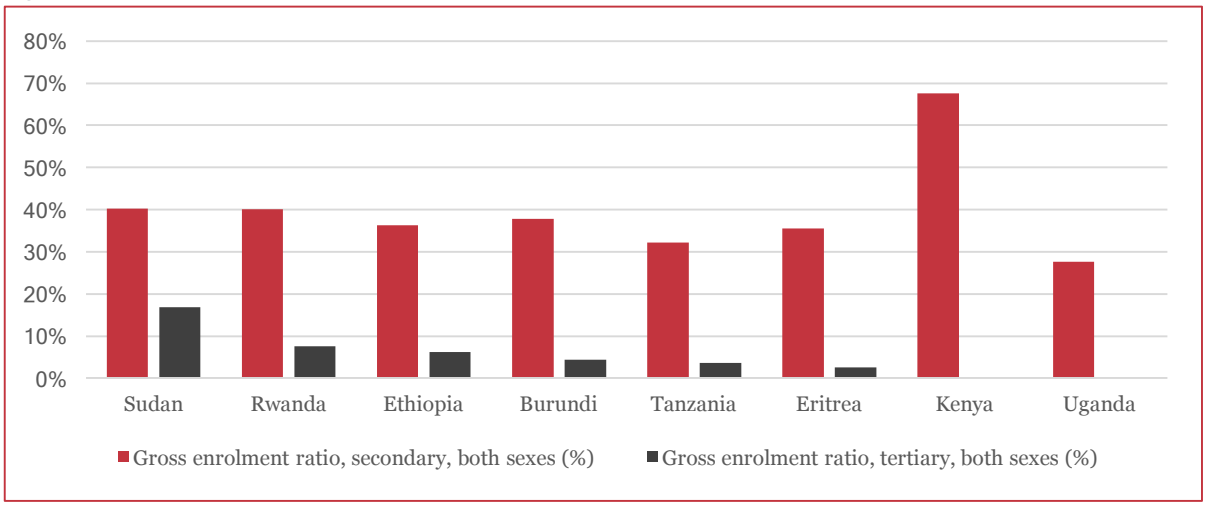
Data from Eurostat, ILO, Cebr analysis, CEBR, 2016. Data missing for Sudan, South Sudan, Somalia, and Eritrea

3.2 Key human capital development framework conditions

In East SSA gross enrolment rates in secondary education ranges from 68% in Kenya to 28% in Uganda (average enrolment in SSA is 47%). Gross enrolment rates in tertiary education ranges from 17% in Sudan to 3% in Eritrea (average enrolment in SSA is 7%).

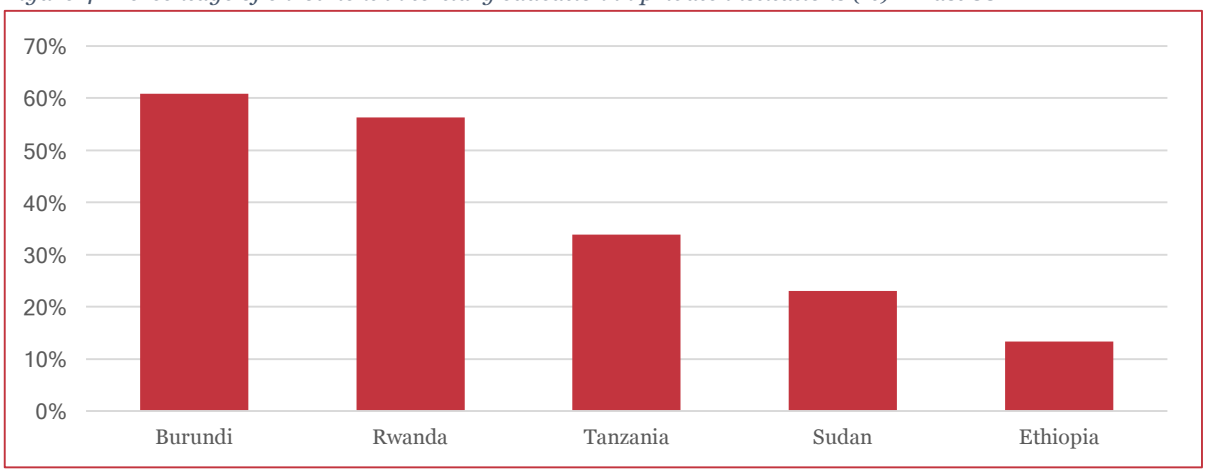
In East SSA, data on percentage of enrolment in tertiary education in private institutions is largely uncollected. However, based on the data available, the percentage is highest in Burundi (61%) and lowest in Ethiopia (13%), see Figure 42.

Figure 41 Enrolment rates – East SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, 2013-2015 (see appendix)
Missing data for South Sudan and Somalia.

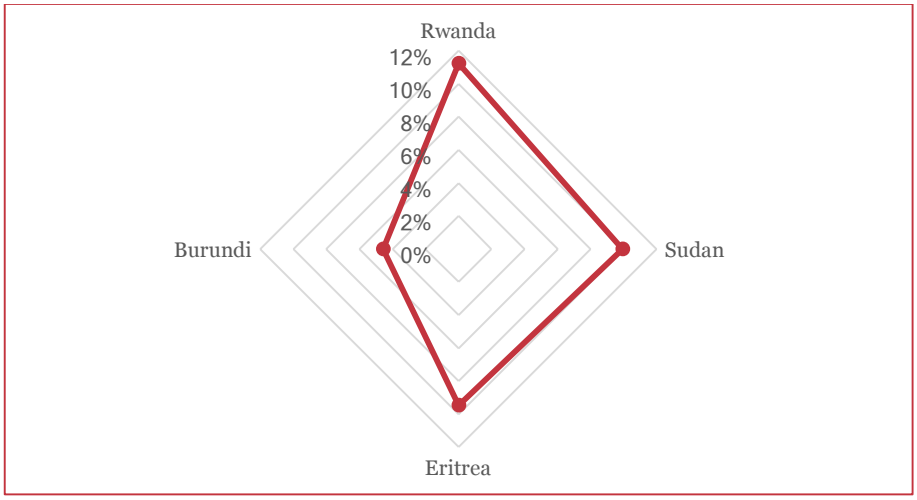
Figure 42 Percentage of enrolment in tertiary education in private institutions (%) – East SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, 2013-2014 (see appendix).
Missing data for Eritrea, Kenya, Somalia, South Sudan, and Uganda

There is limited data available on the percentage of graduates from tertiary education graduating from Science programmes. Based on the data available we find that the percentage of science graduates from Rwanda are relatively high – 12%. The percentage of science graduates is only slightly lower in Sudan and Eritrea (it is 10% in both countries) and only 5% in Burundi (data from Education statistics, World bank, UNESCO Institute for Statistics, 2012-2014 see appendix).

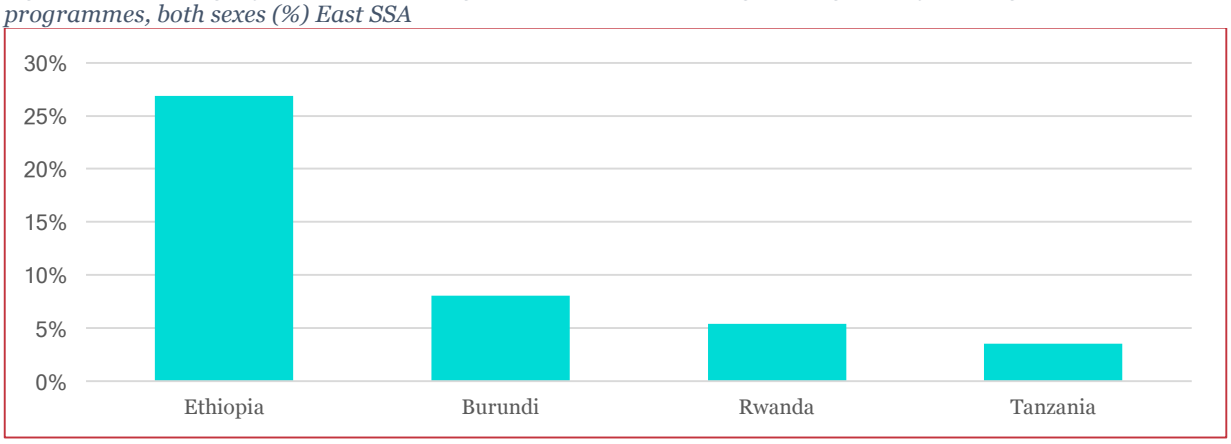
Figure 43 Percentage of graduates from tertiary education graduating from Science programmes, both sexes (%) – East SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, 2012-2014 (see appendix). Missing data for Ethiopia, Kenya, Somalia, South Sudan, Tanzania and Uganda

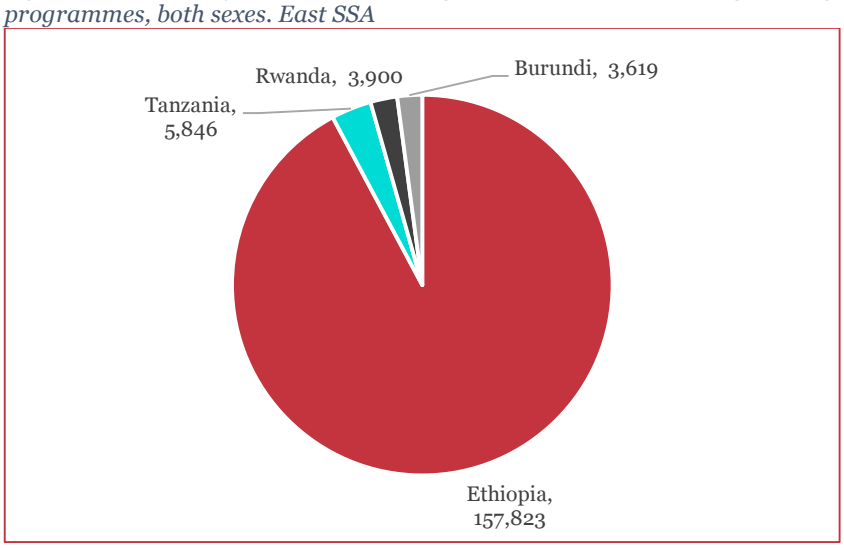
The average percentage of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes in East SSA ranges from 27% in Ethiopia (the highest in SSA), 8% in Burundi, 5% in Rwanda, to 4% in Tanzania. Ethiopia has the highest student population, around 158,000 students, that are enrolled in tertiary Engineering, Manufacturing and Construction programmes in SSA (see Figure 33).

Figure 44 Percentage of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, both sexes (%) East SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, includes data from 2012-2014 Missing data for Eritrea, Kenya, Somalia, South Sudan, Sudan, and Uganda

Figure 45 Number of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, both sexes. East SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, includes data from 2012-2014. Missing data for Eritrea, Kenya, Somalia, South Sudan, Sudan, and Uganda

3.3 Key stakeholders

3.3.1 Regional organisations and engineering organisations

Kenya, Uganda, Tanzania and Rwanda are member of EAFEO/FAEO. FAEO is an international organization that represents the engineering profession and was founded in 1968 with support from UNESCO.

Burundi, Kenya, Rwanda, South Sudan, Tanzania and Uganda are member of the East African Community (EAC).[128] The EAC is a regional intergovernmental organisation that is encouraging progress of the East African Customs Union, the establishment of the Common Market in 2010 and the implementation of the East African Monetary Union Protocol.

Kenya, Tanzania and Uganda are member of the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEC).[129]

3.3.2 Higher education and research institutions

Table 13 presents an overview of the top 10 universities located in East SSA. They are located in Kenya, Ethiopia, Tanzania, Uganda and Sudan.[130]

In Ethiopia, the oldest university is the University of Addis Ababa, established in 1940. As well as the University of Addis Ababa and Jimma University (listed in the top ten), there are a number of other institutes in Ethiopia that focus on technology and engineering:[131]

- AAiT — Addis Ababa Institute of Technology, Addis Ababa
- AASTU — Addis Ababa Science and Technology University, Addis Ababa
- BiT — Bahir Dar Institute of Technology, Bahir Dar
- DDIT — Dire Dawa Institute of Technology, Dire Dawa

[128] http://www.eac.int/

[129] http://www.sacmeq.org/

[130] http://www.webometrics.info/en/Africa

[131] http://www.engineeringethiopia.org/institutes

- EiABC — Ethiopian Institute for Architecture, Building Construction and City Development, Addis Ababa
- EiT-M — Ethiopian Institute of Technology - Mekelle, Mekelle
- IOTec-HU — Hawassa University Institute of Technology, Hawassa
- KiOT — Kombolcha Institute of Technology, Kombolcha

Table 13 Top 10 HEIs in East SSA

Country	Africa Rank	World rank	HEI
Kenya	8	728	University of Nairobi
Uganda	11	1074	Makerere University
Ethiopia	26	1784	Addis Ababa University
Sudan	27	1797	University of Khartoum
Kenya	29	1880	Kenyatta University
Tanzania	33	2054	University of Dar Es Salaam
Tanzania	42	2190	Sokoine University of Agriculture
Kenya	52	2441	Moi University
Kenya	64	2718	Jomo Kenyatta University of Agriculture and Technology
Ethiopia	76	2948	Jimma University

Source: http://www.webometrics.info/en/Africa

3.3.3 Engineering associations

Kenya, Uganda, Tanzania and Rwanda are member of EAFEO. Examples of other engineering associations are presented in the table below.

Table 14 Examples of engineering associations – East SSA

Country	Engineering association	Members	Objectives and Services
Burundi			
Eritrea	Association of Eritrean Engineers AEE		
Ethiopia	Higher Education Engineering in Ethiopia[132]	Institutes of Technology	Provide information on Institutes of Technology and on their research and study programmes.
Ethiopia	Ethiopian Society of Electrical Engineers (ESME)[133]	Engineering professionals and students (members 1,200)	• Support and facilitate all electrical engineering related professions and research in Ethiopia • Organise workshops, seminars and exhibitions to create awareness and give public advice • Managing the STEM Centre (Science, Technology, Engineering and Mathematics Centre) located in Addis Ababa
Ethiopia	Ethiopian Civil Engineering Students Association[134]	Civil engineering students and alumni	• Enhance cooperation and team work amongst members of the association, and creating links with international resourceful contacts to the effect of

[132] http://www.engineeringethiopia.org/

[133] http://www_ethiopian_society_of_electrical_engineers_at_esee_org_et.make-enterprise.net/

[134] http://iaces.net/?pagina=Patrocinador&id=12

Country	Engineering association	Members	Objectives and Services
			encouraging material, expertise and training exchanges both within and outside the Association • Create inspiring environment to fellow students • Generate a multitude of options to the traditional classroom teaching and learning method • Bring civil engineering majors to digital resourceful and paper outlets of information and knowledge • Organise occasions whereby expert and experienced civil engineers share their work experiences to students Help solving civil engineering students' economic, social and psychological problems
Ethiopia	Ethiopian Association of Civil Engineers (EACE)[135] part of the World Federation of Engineering Organisations	Engineering professionals (members 1,250)	Promote and enhance dissemination of knowledge and advancement of Civil Engineering Science and Technology for the benefit of its members and the public at large.
Kenya (International)	Africa Women in Science and Engineering (AWSE)[136]		
Kenya	Institution of Engineers Kenya (IEK)[137]	Individuals (members 3,000)	Promote the general advancement of the science and practice of Engineering and its applications in Kenya and to facilitate the exchange of information and ideas on those subjects amongst the members of the Institution.
Kenya	Association of Consulting Engineers of Kenya (ACEK)[138]	Companies	
Rwanda	Institution of Engineers, Rwanda IER[139]	Individuals	As the national society of engineers for the advancement of engineering in Rwanda, our mission is to advance, promote and develop engineering profession by providing all the expertise necessary for the socio-economic needs of mankind.
Somalia	Somali Engineers Association SEA		
South Sudan	National Society of South Sudanese Engineers NSSSE		
Sudan	Federation of Sudanese Engineers FSE		
Sudan	Sudanese Engineering and Architecture Consultancy Association (SEACA)	Companies	The Sudanese Engineering and Architecture Consultancy Association (SEACA) is an independent body founded in 1987. Its members include all active engineering and architectural firms in the Sudan. The association is a member of the FIDIC, GAMA, and AAEC. Aims of SEACA include developing engineering and architectural practice in the Sudan through identifying solutions to and eliminating obstacles facing practitioners in the field. Through its different activities

[135] http://www.wfeo.org/organizations/ethiopian-association-civil-engineers-eace/
[136] http://www.aawse.org/
[137] http://www.iekenya.org/
[138] http://www.acek.co.ke/
[139] http://www.engineersrwanda.org/

Country	Engineering association	Members	Objectives and Services
			it strives to elevate the standard of engineering and architectural practice and professionals in the field to contemporary international standards.
Tanzania	Institution of Engineers, Tanzania IET[140]	Individuals (members 2,614)	To promote the general advancement of the science and practice of Engineering.
Tanzania	Association of Consulting Engineers Tanzania (ACET)[141]	Companies	ACET is an association made up of consulting engineers who operate in Tanzania. ACET actively promotes the interests of its members, and acts a conduit for the dissemination of relevant information between members, industry associates and clients.
Uganda	Uganda Institution of Professional Engineers UIPE[142]	Individuals	To promote the general advancement of the science and practice of engineering and its applications, and to facilitate the exchange of information and ideas on those subjects amongst the members of the Institution.
Uganda	Uganda Association of Consulting Engineers (UACE)[143]	Companies	The mission of Uganda Association of Consulting Engineers is to develop and promote the consulting engineering industry in Uganda to internationally accepted standards.

3.3.4 Employer associations and major employers

In East SSA there is an East African Employers Organisation, which forms a platform that engages national employer's organisations and other players in the sector on issues that relate to regional integration especially on the implementation aspect of EAC Common Market Protocol concerning the clauses on free movement of labour; labour standards and regulatory environments; skills development and mutual recognition.[144]

Out of the ten East SSA countries six have employment organisations that are member of the International Organisation of Employers (IOE) – see Table 15. For example, in Ethiopia there is the Ethiopian Employer Association (EEF),[145] which is a national employers' organisation that has branches all over Ethiopia and has sectoral associations of the private sector. EEF was established in 1964, dissolved in 1978 and re-established in 1997. Amongst others, the organisation is involved in lobbying and advocacy, e.g. to improve national policies and legislation and investment in human capital development. EEF also provides networking services linking members to international bodies and business organisations.

Table 15 Overview of employer organisations that are member of the International Organisation of Employers – East SSA

Country	Sector
Burundi	Association des Employeurs du Burundi (AEB)
Eritrea	
Ethiopia	Ethiopian Employers' Federation (EEF)
Kenya	Federation of Kenya Employers (FKE)
Rwanda	

[140] http://www.iet.co.tz/

[141] www.acet.or.tz

[142] http://www.uipe.co.ug/

[143] http://www.uace.or.ug/

[144] http://www.eabc.info/platforms/employers_organisation

[145] http://www.eef-ethiopia.org/index.php/en/

Country	Sector
Somalia	
South Sudan	
Sudan	Sudanese Businessmen & Employers Federation (SBEF)
Tanzania	Association of Tanzania Employers (ATE)
Uganda	Federation of Uganda Employers (FUE)

Source: http://www.ioe-emp.org/ioe-members/

In East SSA there are 4 companies that are in the top 250 Africa Businesses ranking[146] active in sectors related to engineering. These companies are: Ethiopian Airlines, Kenyan Airways, Safaricom, and Sudanese Telecom Co – see Table 16. There are also other large companies active in the region such as[147] MIDROC Ethiopia, Sunshine Investment Group, Messobo Cement, East Africa Holding, DH Geda Trade & Industry, Addis-Mojo Edible Oil Complex SC, and Yesu Metal Works.

Table 16 Overview of African companies in the top 500 active in engineering related sectors

Country	Sector	Company	Turnover ($k)
Ethiopia	AIR TRANSPORT	ETHIOPIAN AIRLINES	1,419,449
Kenya	AIR TRANSPORT	KENYA AIRWAYS	1,248,368
Kenya	TELECOMS	SAFARICOM	1,237,938
Sudan	TELECOMS	SUDANESE TELECOM CO.	594,369

Source: http://www.theafricareport.com/top-500-companies-in-africa-2013.html

3.3.5 National policy makers / agencies, research councils and founding bodies

The ministries that contribute to shaping education and research include ministries of education and ministries of technology:

- Somalia - Ministry of Education
- Ethiopia - Ministry of Education and the Ministry of Science and Technology
- Kenya - Ministry of Education, Science and Technology
- Rwanda - Ministry of Education, Science Technology and Scientific Research

In Ethiopia, the Ministry of Education finances a public tertiary system that includes the provision of free non-academic services to regular students. Full-time students pay no fees and part time students pay fees. University income generation activities supplement government funding. Universities have implemented a range of supplementary funding activities including offering extension programmes, summer programmes, short term training, distance learning programmes and consultancy services.[148] Also in Ethiopia, the Ministry of Science and Technology (MoST) encourages and promotes scientific and technological innovation and research through, for example, the 2015/16 7th national science, technology innovation awards research grants.[149]

[146] http://www.theafricareport.com/top-500-companies-in-africa-2013.html

[147] http://ethiopialist.com/articles/65

[148] Munyua et al. (2010) Financing of higher education in Africa: A case of Ethiopia public universities revenue diversification strategies. International Journal of Business and Public Management (ISSN: 2223-6244) Vol. 1(1): 15-21. http://www.mku.ac.ke/research/images/journals/vol%201/Financing%20of%20Higher%20Education%20in%20Africa-%20A%20Case%20of%20%20Ethiopia%20Public%20Universities%20Revenue%20Diversification%20Strategies.pdf

[149] http://www.most.gov.et/research-grants

In Kenya, the Engineers Board of Kenya (EBK) regulates engineering and practice and is likewise a key stakeholder, as is the Commission for University Education (CUE).

In Tanzania, the Engineering Registration Board, a governmental organisation, been given the responsibility of monitoring and regulating engineering activities and the conduct of the engineers and engineering consulting firms in Tanzania. through registration of engineers and engineering consulting firms. In Tanzania, similarly to Nigeria and Kenya in West SSA, relevant legislation requires companies who employ engineers to train a certain number of engineers. Another important stakeholder in the country is the Tanzania Commission for Science and Technology (COSTECH). Accreditation, registration and approval of higher education institutions is carried out by the Tanzania Commission for Universities (TCU), the successor of the former Higher Education Accreditation Council since 2005.

3.4 International schemes and initiatives focusing on East SSA

The following countries are part of the Africa-EU partnership – Tuning Africa:[150]

- Burundi
  - Hope Africa University
  - University of NGOZI
- Eritrea
  - College of Business and Economics
  - Eritrea institute of technology
- Ethiopia
  - Adama Science and Technology University
  - Arsi University
  - Dilla University
  - Institute of Architecture, Building Construction and City Development
  - Jimma University
  - Mekelle University
  - St. Mary's University
- Kenya
  - African Virtual University
  - Egerton University
  - Jomo Kenyatta University of Agriculture and Technology
  - Kenyatta University
  - Masinde Muliro University of Science and Technology
  - Moi University
  - University of Nairobi
- Rwanda
  - University of Rwanda
- Somalia
  - Mogadishu University
  - University of Health Sciences
- South Sudan

[150] http://tuningafrica.org/en/participating-countries/

  - University of Juba
- Sudan
  - Sudan University of Science and Technology
- Tanzania
  - Open University of Tanzania
  - University of Dar es Salaam
- Uganda
  - Makerere University

A selection of examples of international research projects in the field of engineering are presented below.

- Joint research project of EiABC and the Swiss Federal Institute of Technology in Zurich.[151] This project 'Contextualization of Vocational Training for the Building Sector in Ethiopia' was funded by the Arthur Waser Foundation, based in Lucerne Switzerland. The project was initiated in 2010 (by Professor Dr. Elias Yitbarek) with funding from the Arthur Waser Foundation for a pilot project that was called SRDU (Sustainable Rural Dwelling Unit), launched in 2011. The pilot involved building two housing units and experimentation with local building materials combined with new building techniques and autonomous operating energy supply units. The Arthur Waser Foundation continued working with both EiABC and the Wolkite Polytechnic College under the 'Rural Housing' project launched in 2013. This project involved various workshops and contributes to establishing PhD research programs and curriculum development for Technical Vocational Training Centres in Ethiopia[152]
- The Ethiopian Institute for Architecture, Building Construction and City Development worked on the project SICU[153] (2011-2015), short for Sustainable Incremental Construction Unit. The project is an experimental process oriented building prototype to be used as a show case for the design and realisation of an incremental housing unit in an urban context. SICU is part of The "Welcome Africa" project 2012-2015 at DAAD (German Academic Exchange Service), an international academic research project between the Ethiopian, South Sudanese and German universities
- PhD students at Bahir Dar Institute of Technology (Ethiopia), funded by USAID, Partnership for Enhanced Engagement in Research (PEER) (2014-2017) are studying the reducing soil loss through effective soil and water conservation practices using hydrologic considerations and farmers' participation in Blue Nile Basin. "Soil erosion decreases food production and hampers poverty reduction efforts in the highlands of eastern Africa (…) The goal of the proposed research is to develop appropriate watershed and farmer-based erosion control practices for the Ethiopian highlands in order to replace the well minded imported and inappropriate technologies from foreign donors"[154]
- USAID, Partnership for Enhanced Engagement in Research (PEER) also supported a collaboration between George Mason University and the Nelson Mandela African Institution of Science and Technology in Tanzania on the project Computational Mathematics, Modelling and Analysis of Biological, Bio-inspired and Engineering Systems.[155] The project aimed to promote capacity building by creating a "broad network of knowledgeable scientists and researchers who will start to collaborate to tackle some of the most urgent problems in food security, environment, education, water and global health affecting Tanzania and neighbouring

[151] http://www.eiabc.edu.et/index.php/research/research/srdu-project?showall=1

[152] https://admin.arch.ethz.ch/CQ5Code/iframe/forschung_projekte_institut.php?lang=en&pageid=1&leitzahl=3919&projekt_id=3092

[153] http://www.engineeringethiopia.org/project/sicu-sustainable-incremental-construction-unit

[154] http://www.engineeringethiopia.org/project/reducing-soil-loss-through-effective-soil-and-water-conservation-practices-using-hydrologic-

[155] http://sites.nationalacademies.org/PGA/PEER/PEERscience/PGA_084056

countries". The project involved a three-week training course for 30 members early career researchers, graduate and post-graduate students working on multidisciplinary applications of mathematics

- Norway supports the training and professional development of female engineers in Tanzania and has granted Tanzania $2.1m to train 150 female engineers over a five-year period.[156] The Chairman of the Engineering Registration Board (ERB) announced that since the collaborative programme between Tanzania and Norway started in 2003, 3,555 graduate engineers have benefitted, including 847 female engineers

The following are winners of the 2015-2016 RAEng Africa Prize for Engineering Innovation[157]

- Uganda: Kamata power theft prevention system

  "Electricity theft causes financial losses and disrupts access to power for homes and businesses. Kamata is a system designed to notify power utilities when meters are manipulated or tampered with. It cuts the power supply and sends the location, metre number and type of interference to a control centre. It also enables the control centre to restore power after an incident is resolved"

- Kenya: UjuziKilimo

  "UjuziKilimo is an analytical system that measures soil characteristics to help farmers understand and quantify soil qualities. Information is collected by an electronic sensor inserted into the ground, which sends it to a central database for analysis. Farmers receive a text message with a guide on the soil, and personalised advice on preferred crop breeds, pest control, current market value of crops, tools required and where to find them. UjuziKilimo is powered by a central database which collects agricultural information from research institutions, universities, and financial markets in order to provide this information to farmers"

- Kenya: Totohealth

  "Totohealth is an information system that guides parents through pregnancy and childhood by sending them vital maternal and child health information via text-messages. Text messages are sent to parents twice a week based on when they registered their pregnancy or birth of a child. The messages provide information on nutrition, immunisation, hygiene, breastfeeding, family planning and childhood diseases. Totohealth helps them to identify abnormalities and advise the milestones and changes to expect from infants and toddlers. Parents are registered for the messaging service by hospitals, clinics, community workers or NGOs"

- Kenya: Illuminum Greenhouse

  "Illuminum is a greenhouse made with local materials. Its solar panel and sensor technology creates a controlled environment in which to grow crops. In doing so, it addresses many of the challenges faced by Kenyan farmers, including climate change, unpredictable weather, pests, crop diseases and old technology. The sensors collect data on temperature, humidity and soil moisture and send this to farmers via text message, allowing them to monitor and regulate their greenhouse without having to be on the farm. Irrigation can also be turned on and off via text message. The system works on all types of phones and the use of solar power makes Illumininum ideal for rural areas with poor access to energy"

- Tanzania: Managing medical supplies

  "This web-based monitoring software is designed to combat the theft of medical supplies across the Tanzanian hospital network. By monitoring medicine inventories at the national medical store and in hospitals, and reporting discrepancies to the Ministry of Health, it cuts healthcare costs and helps ensure medicines are available to those who need them"

[156] https://www.newsghana.com.gh/norway-grants-tanzania-us2-1-million-for-development-of-female-engineers/

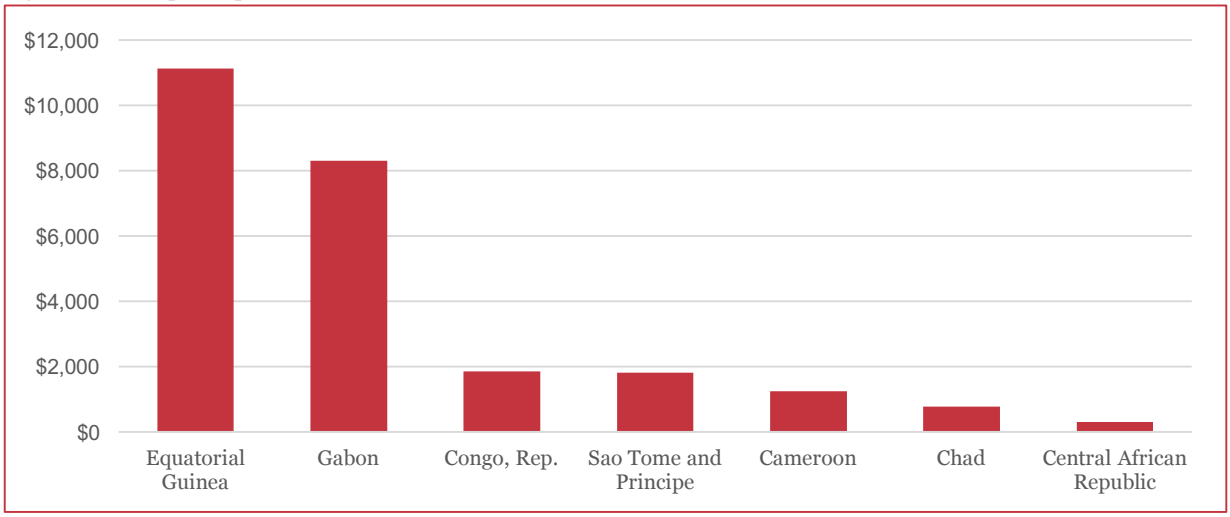
[157] http://www.raeng.org.uk/grants-and-prizes/international-research-and-collaborations/africa-prize/current-and-recent-awards

4 Central SSA

4.1 Key economic framework conditions

GDP per capita in Central SSA ranges from around $11,100 in Equatorial Guinea and $8,300 in Gabon to around £300 in the Central African Republic. GDP per capita of the Republic of the Congo and Sao Tome and Principe, both around $1,800, is relatively close to the average GDP per capita in SSA, which is $2,200.

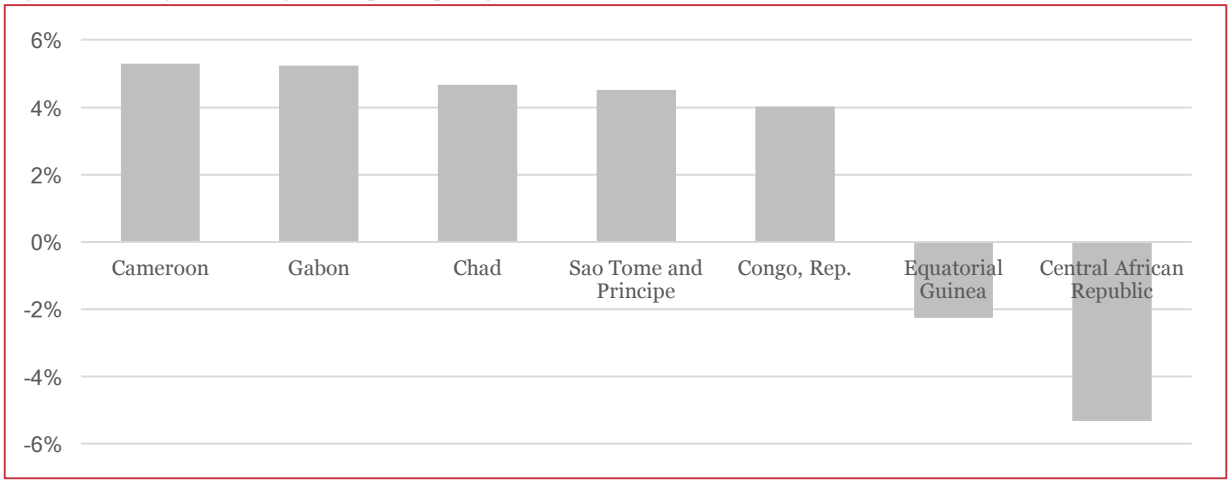
Figure 46 GDP per capita – Central SSA



Source: Data on GDP (current $US) from World Bank national accounts data, and OECD National Accounts data files. Population statistics from United Nations World Population Prospects. Data for Sao Tome and Principe are from 2014. All other data from 2015

Five-year average growth rates in Central SSA range from just over 5% in Cameroon to close to negative 5% in the Central African Republic. Five-year average growth rates are 2.3%, which is just above half of the five-year average growth rates in SSA (4.3%).

Figure 47 Five year average GDP per capita growth – Central SSA

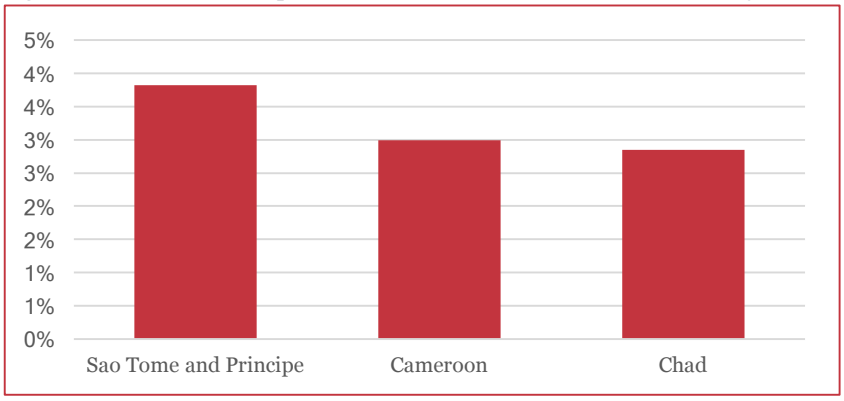


Source: World Bank national accounts data, and OECD National Accounts data files, 2011-2015. Missing data for 2015 for Dao Tome and Principe.

There is only limited data on Government expenditure on educational institutions as a percentage of GDP. Based on the data available, the percentage spent varies from 4% in Sao Tome and Principe to 3% in Cameroon and Chad – see figure below. Expenditure as a percentage of population in these countries

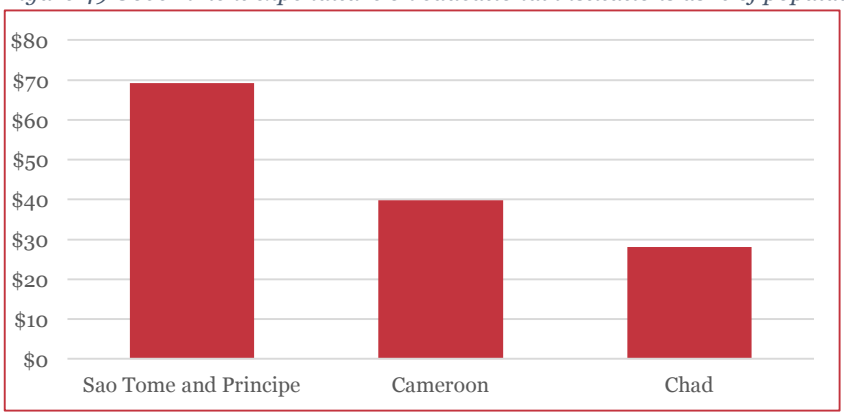
is equal to just below $70 per person in Sao Tome and Principe, around $40 in Cameroon and around $28 in Chad.

Figure 48 Government expenditure on educational institutions as % of GDP (%) – Central SSA



Source: Data from Education statistics, World bank, UNESCO. Data from latest year available (2014, 2013, or 2012 – See table in Appendix) – missing data for Gabon, Equatorial Guinea, Congo, Rep., and Central African Republic.

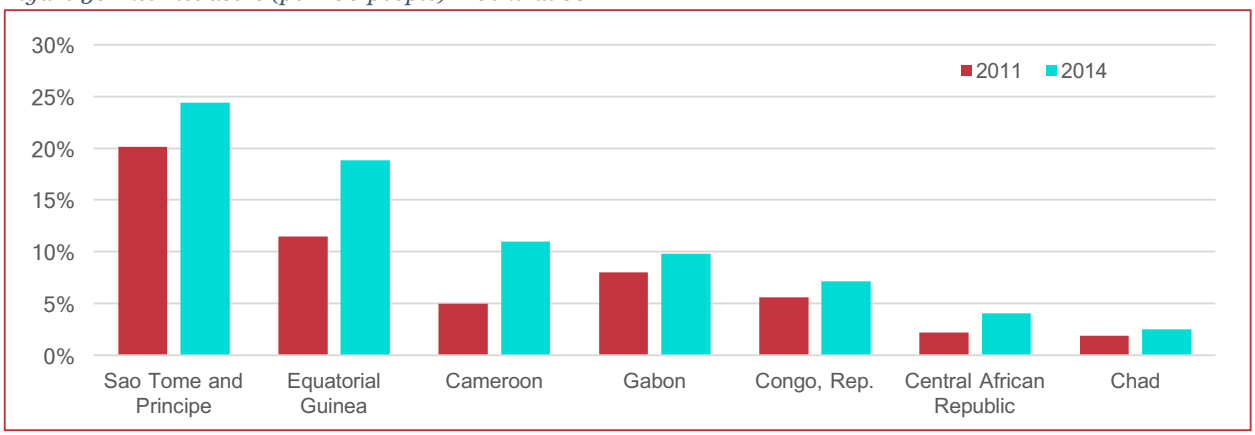
Figure 49 Government expenditure on educational institutions as % of population (US dollar) – Central SSA



Source: Data from Education statistics, World bank, UNESCO. Data from latest year available (2014, 2013, or 2012 – See table in Appendix) – missing data for Gabon, Equatorial Guinea, Congo, Rep., and Central African Republic. Data on GDP (current $US) from World Bank national accounts data, and OECD National Accounts data files. Population statistics from United Nations World Population Prospects.

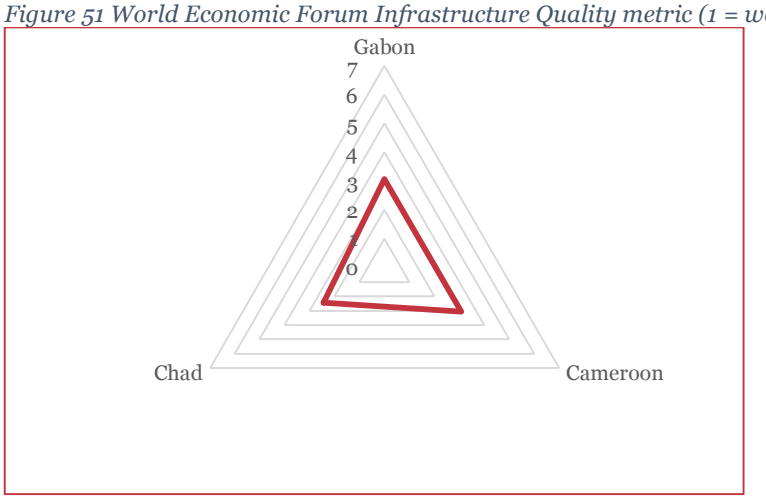
The percentage of the population using the internet has risen rapidly in the past few years in SSA from 10% in 2011 to 15% in 2014. In Central SSA internet use increased from 8% on average in 2011 to 11% on average in 2014. Countries with the highest percentage of population using the internet are Sao Tome and Principe – 24% - and Equatorial Guinea - 19% - in 2014. The score of Gabon and Cameroon on the WEF composite infrastructure indicator is close to the average score in SSA (3.3) and the score of Chad is relatively low.

Figure 50 Internet users (per 100 people) – Central SSA



Source: International Telecommunication Union, World Telecommunication/ICT Development Report and database, and World Bank estimates

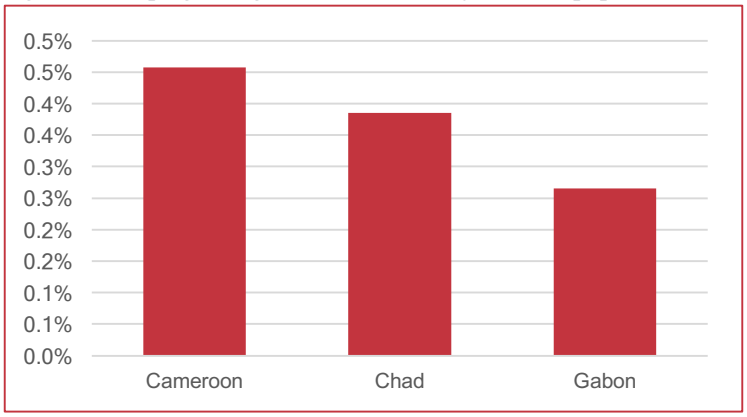
Figure 51 World Economic Forum Infrastructure Quality metric (1 = worst, 7 = best). – Central SSA



Data from CEBR, 2016. Data missing for Sao Tome and Principe, Cameroon, Central African Republic, Equatorial Guinea, and Congo, Rep.

Based on the data shown in Figure 52, the number of employed engineers as a percentage of the total population is highest in Cameroon (around 0.5%) and is lowest in Gabon (around 0.3%).

Figure 52 Employed engineers as a share of the total population – Central SSA



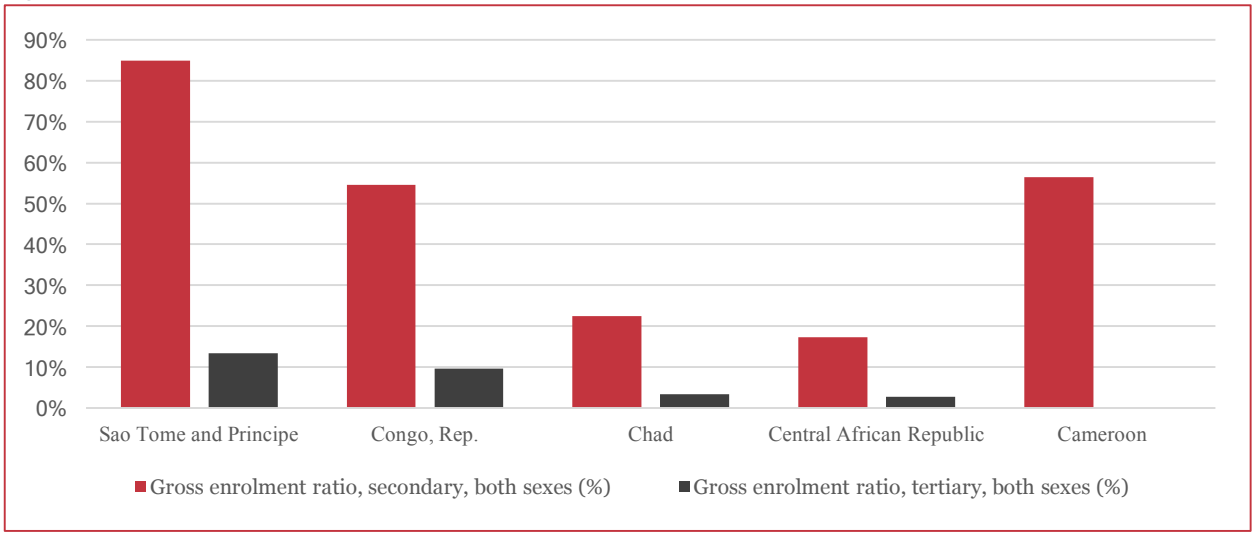
Data from Eurostat, ILO, Cebr analysis, CEBR, 2016. Data missing for Sao Tome and Principe, Cameroon, Central African Republic, Equatorial Guinea, and Congo, Rep.

4.2 Key human capital development framework conditions

In Central SSA gross enrolment rates in secondary education ranges from 85% in Sao Tome and Principe to 17% in the Central African Republic (average enrolment in SSA is 47%). Gross enrolment rates in tertiary education ranges from 13% in Sao Tome and Principe to 3% in Chad and the Central African Republic (average enrolment in SSA is 7%).

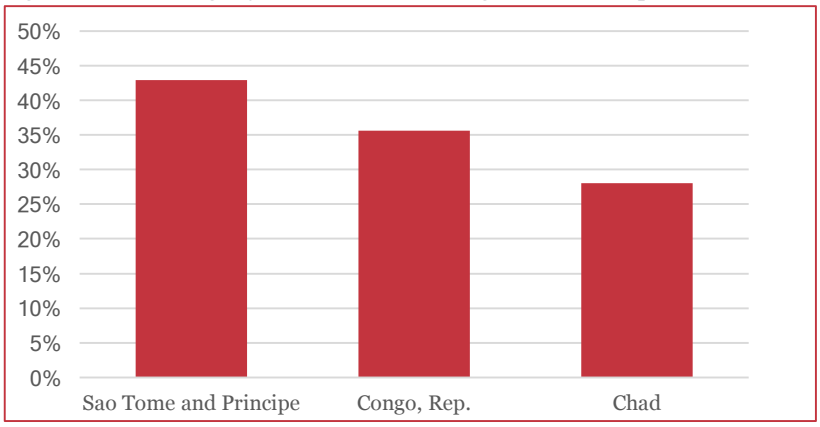
As for some other regions, in Central SSA, data on percentage of enrolment in tertiary education in private institutions is largely uncollected. However, based on the data available, the percentage is highest in Sao Tome and Principe (43%) and lowest in Chad (28%), see Figure 54.

Figure 53 Enrolment rates – Central SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, 2013-2015 (see appendix). Missing data for Equatorial Guinea and Gabon

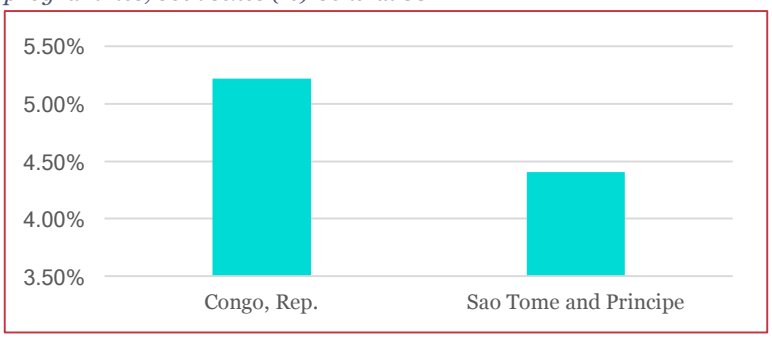
Figure 54 Percentage of enrolment in tertiary education in private institutions (%) – Central SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, 2013-2014 (see appendix). Missing data for Cameroon, the Central African Republic, Equatorial Guinea, and Gabon.

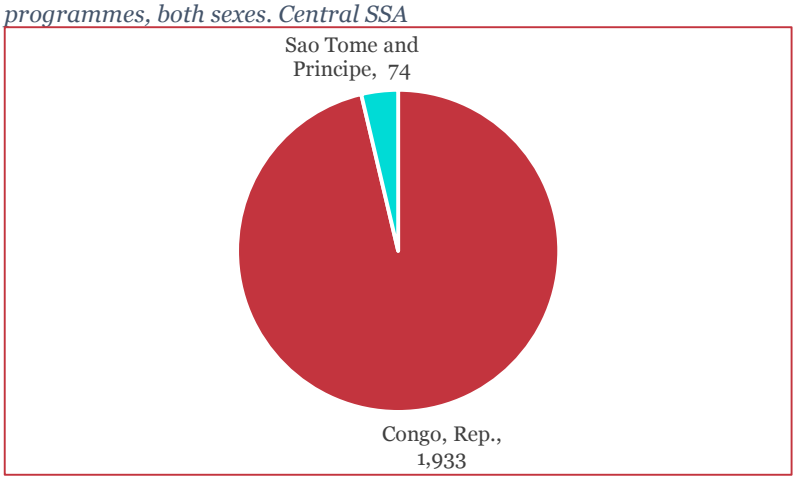
The average percentage of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes in SSA is 9% and the percentage of enrolment in the Republic of the Congo and Sao Tome and Principe falls below this average. In the Republic of the Congo the size of the student population enrolled in tertiary education for Engineering, Manufacturing and Construction programmes is close to 2,000. In Sao Tome and Principe it only is 74 – see Figure 56.

Figure 55 Percentage of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, both sexes (%) Central SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, includes data from 2013 and 2014. Missing data for Cameroon, Central African Republic, Chad, Equatorial Guinea, and Gabon.

Figure 56 Number of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, both sexes. Central SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, includes data from 2012-2014. Missing data for Cameroon, Central African Republic, Chad, Equatorial Guinea, and Gabon.

4.3 Key stakeholders

4.3.1 Regional organisations and engineering organisations

Cameroon, Chad and Gabon are member of CAFEO/FAEO. FAEO is an international organisation that represents the engineering profession and was founded in 1968 with support from UNESCO.

4.3.2 Higher education and research institutions

Table 17 presents an overview of the top 10 universities located in Central SSA. These are located in Cameroon and the Central African Republic.[158]

Table 17 Top 10 HEIs in Central SSA

Country	Africa Rank	World rank	HEI
Cameroon	102	3368	Université de Dschang
Cameroon	125	3948	Université de Yaounde I
Cameroon	201	6855	University of Buea
Cameroon	212	7171	Université de Douala

[158] http://www.webometrics.info/en/Africa

Country	Africa Rank	World rank	HEI
Cameroon	219	7407	Université de Ngaoundéré
Cameroon	261	9403	Université de Yaounde 2
Cameroon	264	9678	Institut de Formation et de Recherche Démographiques Cameroun
Cameroon	412	14323	Université Catholique d'Afrique Centrale
Cameroon	500	15726	Université des Montagnes
Central African Republic	571	16866	Université de Bangui

Source: http://www.webometrics.info/en/Africa

4.3.3 Engineering associations

Cameroon, Chad and Gabon are member of CAFEO. Examples of other engineering associations are presented in the table below.

Table 18 Examples of engineering associations – Central SSA

Country	Engineering association	Members	Objectives and Services
Cameroon	Engineering Association of Cameroon		
Cameroon	Cameroon Association of Active Youths (CAMAAY)[159]	Individuals	The mission of the programme[160] is to support high impact engineering projects in Cameroon by combining community driven ideas with professional and student design. The Association provides underserved communities with cost efficient and sustainable projects aimed at improving the standard of living. Professionals and students gain real world experience working on projects in a wide range of engineering disciplines that promote a sense of international responsibility
Cameroon	Association of Professional Engineers Consulting and Engineering (APICCAM)[161]	Individuals	Defending the interests of members and improving the quality of services rendered.
Central African Republic			
Chad	Association of Chad Engineers ACE		
Congo, Rep.			
Equatorial Guinea			
Gabon	Association of Engineers, Gabon AEG		
Sao Tome and Principe			

[159] https://camaay.ngo/about-2/

[160] http://idm.epfl.ch/site/sites/idm.epfl.ch/files/documents/projects_activites/CAMEROON%20ASSOCIATION%20OF%20ACTIVE%20YOUTHS%20(CAMAAY)/ENGINEERS%20FOR%20AN%20EMERGING%20CAMEROON%20BY%202035.pdf

[161] http://www.apiccam.org/

4.3.4 *Employer associations and major employers*

Four of the seven Central SSA countries have employment organisations which are members of the International Organisation of Employers (IOE) – see Table 19.

Table 19 Overview of employer organisations that are member of the International Organisation of Employers – Central SSA

Country	Sector
Cameroon	Groupement Inter-Patronal du Cameroun (GICAM)
Central African Republic	
Chad	Conseil National du Patronat Tchadien (CNPT)
Congo, Rep.	Union Patronale et Interprofessionnelle du Congo (UNICONGO)
Equatorial Guinea	
Gabon	Confédération Patronale Gabonaise (CPG)
Sao Tome and Principe	

Source: http://www.ioe-emp.org/ioe-members/

In Central SSA there are no companies that are in the top 250 Africa Businesses ranking[162] active in sectors related to engineering.

4.3.5 *National policy makers / agencies, research councils and founding bodies*

The ministries contributing to shaping education and research include ministries of education and ministries of technology. In Cameroon, there is a Minister of Scientific Research and Innovation, a Minister of Youth Affairs and Civic Education, a Minister of Basic Education, a Minister of Secondary Education, a Minister of Higher Education, and a Minister of Employment and Vocational Training.[163] Sao Tome and Principe has a Ministry of Education, Culture, Youth and Sports.

4.4 International schemes and initiatives focusing on Central SSA

The following countries are part of the Africa-EU partnership – Tuning Africa[164]:

- Cameroon
  - Université de Douala
  - Université de Yaoundé I
  - University of Dschang
  - University of Maroua
  - University of Yaoundé II
- Gabon
  - Université Omar BONGO

A research team from Cameroon is one of the winners of the 2015-2016 RAEng Africa Prize for Engineering Innovation[165]

- Cardio-Pad: "Cameroon has 50 cardiologists for its 22 million citizens. The Cardio-Pad is a medical tablet that enables heart examinations and diagnosis to be done remotely by doctors

[162] http://www.theafricareport.com/top-500-companies-in-africa-2013.html

[163] http://www.cameroonpostline.com/here-is-the-complete-list-of-cameroons-new-govt/

[164] http://tuningafrica.org/en/participating-countries/

[165] http://www.raeng.org.uk/grants-and-prizes/international-research-and-collaborations/africa-prize/current-and-recent-awards

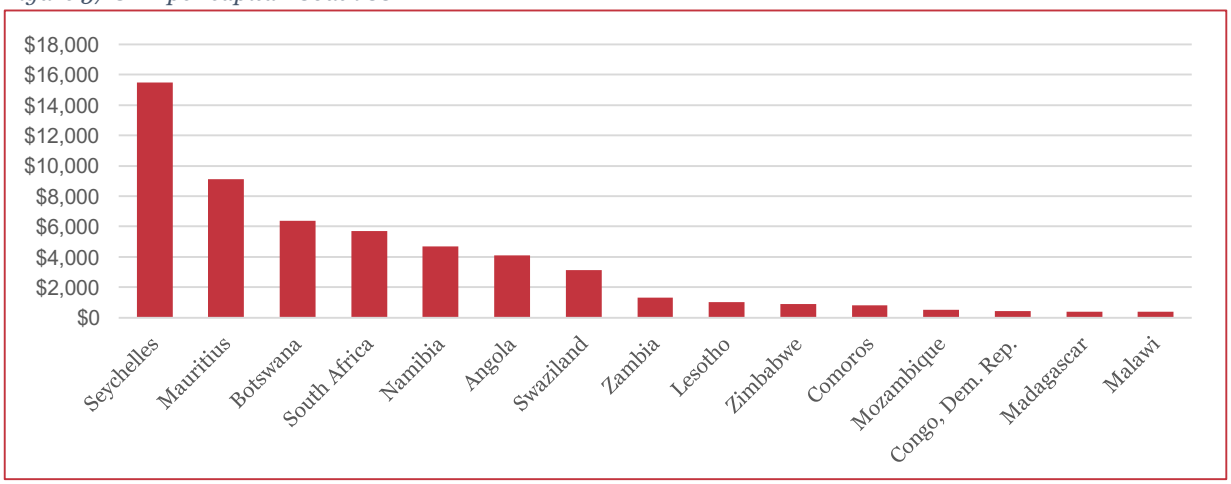
and nurses. The Cardio-Pad produces a digitized electrocardiogram (ECG) to assess heart conditions and a patient's heartbeat. This information is sent by a mobile phone network to a cardiologist, who can interpret the data and send their diagnosis and instructions back to the local doctor or nurse"

5 South SSA

5.1 Key economic framework conditions

GDP per capita in South SSA ranges from more than $15,00 in Seychelles (by far the highest in SSA) to around £380 in Malawi. The average GDP per capita in South SSA is just over $3,600, which is well above the average GDP per capita in SSA ($2,200).

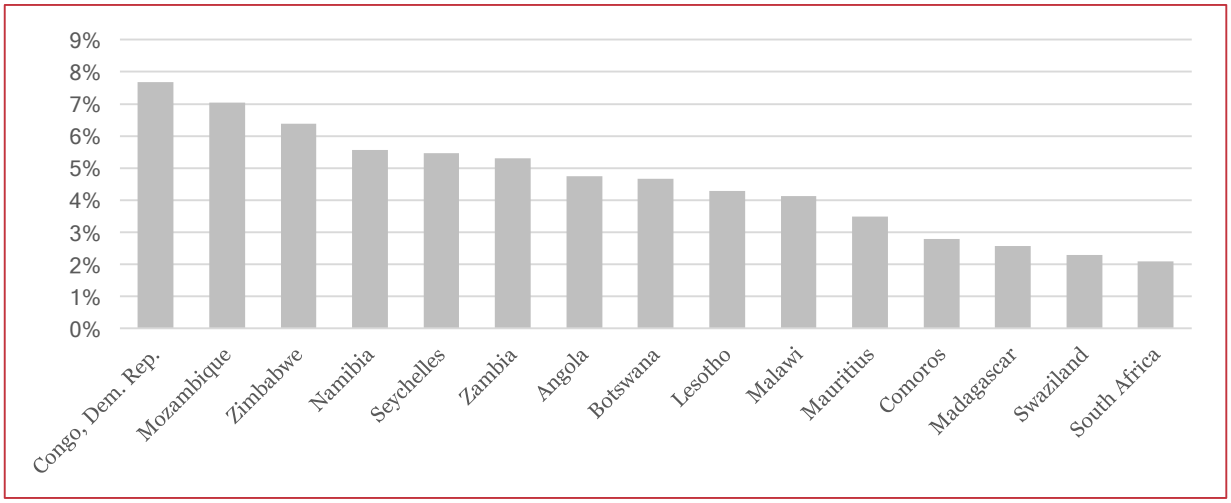
Figure 57 GDP per capita –South SSA



Source: Data on GDP (current $US) from World Bank national accounts data, and OECD National Accounts data files. Population statistics from United Nations World Population Prospects. Data for Lesotho and Mozambique are from 2014. All other data from 2015

Five-year average growth rates in South SSA range from more than 7% in the Democratic Republic of Congo to around 2% in South Africa. Five-year average growth rates for the region are 4.6%, which is slightly above the five-year average growth rates in SSA (4.3%).

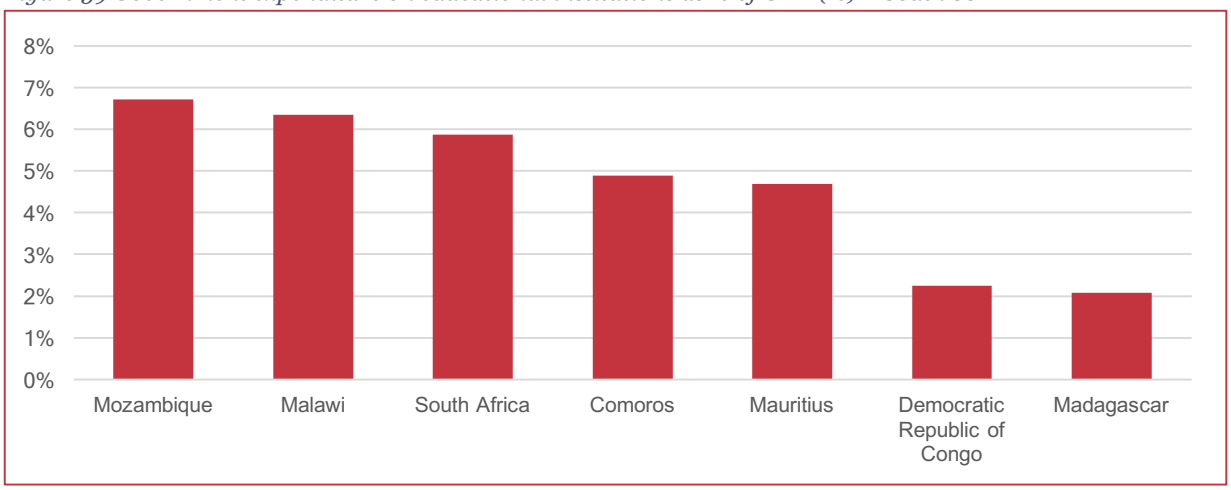
Figure 58 Five year average GDP per capita growth –South SSA



Source: World Bank national accounts data, and OECD National Accounts data files, 2011-2015. Missing data for 2015 for Comoros and Lesotho

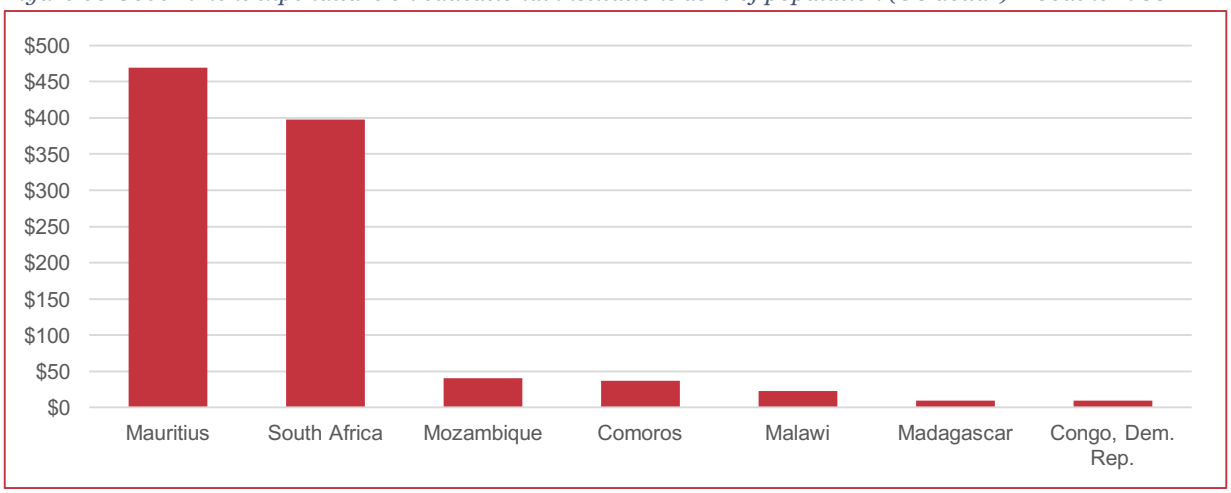
Government expenditure on educational institutions as a percentage of GDP varies across the region and ranges from 7% in Mozambique (the highest in SSA) to 2% in Madagascar – see figure below. Expenditure as a percentage of population in the region ranges from $469 per person in Mauritius (the highest in SSA) and $397 per person in South Africa to around $40 per person in Mozambique and only $9 per person in the Democratic Republic of Congo. Government expenditure on educational institutions is also relatively low in term of percentage of GDP and percentage of population in countries such as Comoros, Malawi and Madagascar.

Figure 59 Government expenditure on educational institutions as % of GDP (%) – South SSA



Source: Data from Education statistics, World bank, UNESCO. Data from latest year available (2014, 2013, or 2012 – See table in Appendix) – missing data for Zimbabwe, Zambia, Swaziland, Seychelles, Namibia, Lesotho, Botswana, and Angola

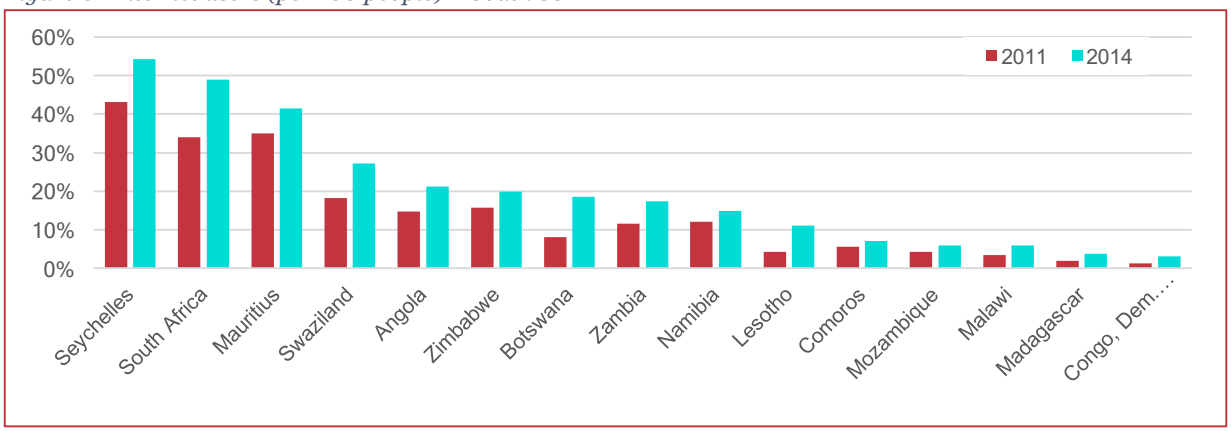
Figure 60 Government expenditure on educational institutions as % of population (US dollar) – Southern SSA



Source: Data from Education statistics, World bank, UNESCO. Data from latest year available (2014, 2013, or 2012 – See table in Appendix) – missing data for Zimbabwe, Zambia, Swaziland, Seychelles, Namibia, Lesotho, Botswana, and Angola Data on GDP (current $US) from World Bank national accounts data, and OECD National Accounts data files. Population statistics from United Nations World Population Prospects.

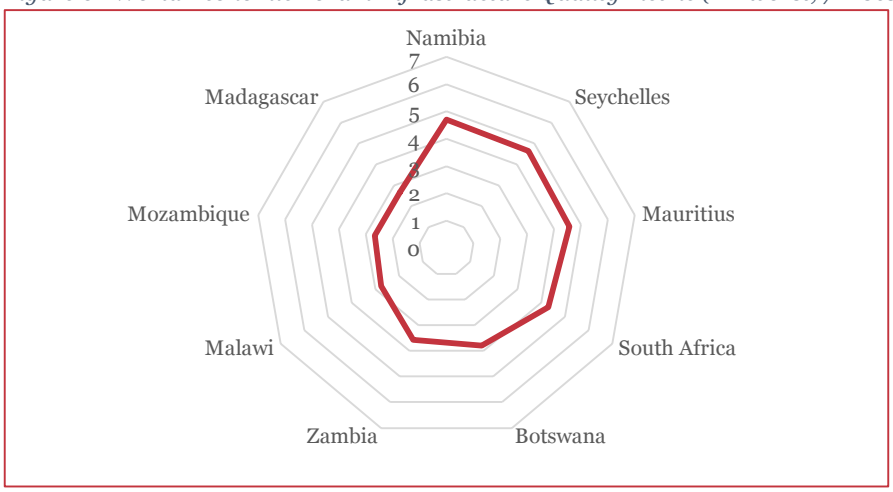
The percentage of the population using the internet has risen rapidly in the past few years in SSA from 10% in 2011 to 15% in 2014. In South SSA the internet use increased from 14% on average in 2011 to 20% on average in 2014. Countries with the highest percentage of population using the internet are Seychelles – 54% - and South Africa - 49% - in 2014 (the highest percentages in SSA). The countries in South SSA that score highest on the WEF composite infrastructure indicator are Namibia, Seychelles, Mauritius and South Africa – see Figure 62.

Figure 61 Internet users (per 100 people) – South SSA



Source: International Telecommunication Union, World Telecommunication/ICT Development Report and database, and World Bank estimates

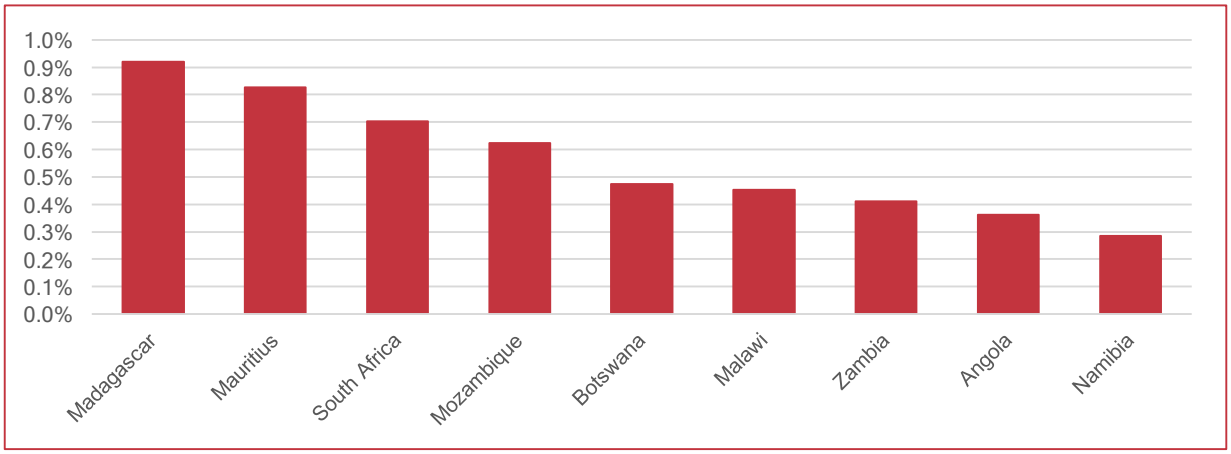
Figure 62 World Economic Forum Infrastructure Quality metric (1 = worst, 7 = best). –South SSA



Data from CEBR, 2016. Data missing for Angola, Swaziland, Zimbabwe, Lesotho, Comoros, and Congo Dem. Rep.

The number of employed engineers as a percentage of the total population is highest in Madagascar (0.9%) and Mauritius (0.8%), it is lowest in Namibia (close to 0.3%) – see Figure 63.

Figure 63 Employed engineers as a share of the total population – South SSA



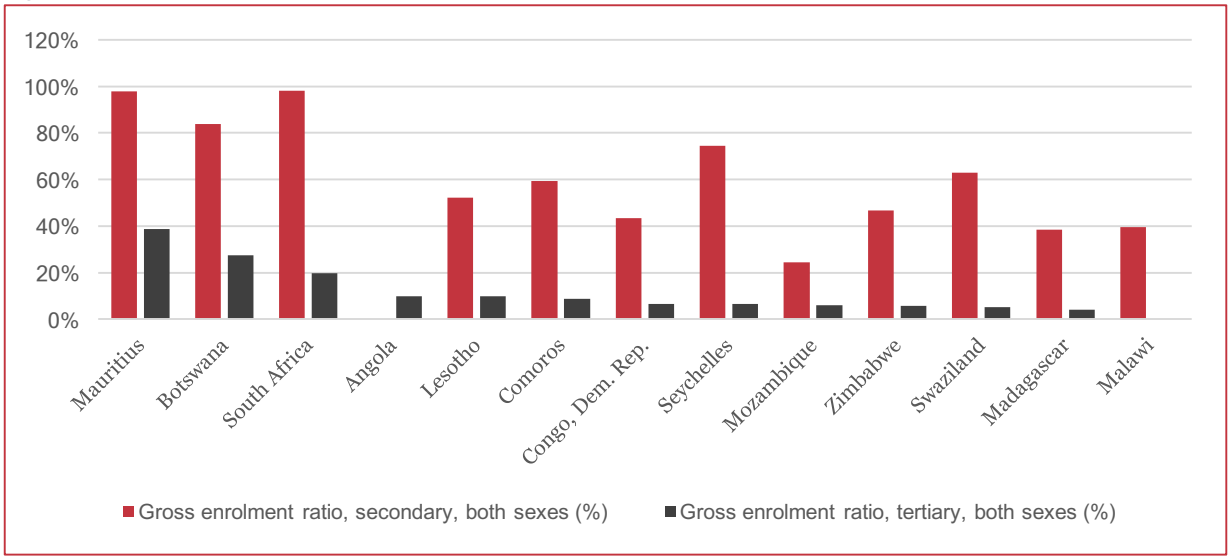
Data from Eurostat, ILO, Cebr analysis, CEBR, 2016. Data missing for Swaziland, Zimbabwe, Lesotho, Comoros, and Congo Dem. Rep.

5.2 Key human capital development framework conditions

In South SSA gross enrolment rates in secondary education ranges from 98% in and South Africa Mauritius, the highest enrolment rates in SSA, to 25% in Mozambique. Average enrolment in SSA is 47%. Gross enrolment rates in tertiary education ranges from 39% in Mauritius (the highest in SSA) to 4% in Madagascar (average enrolment in SSA is 7%).

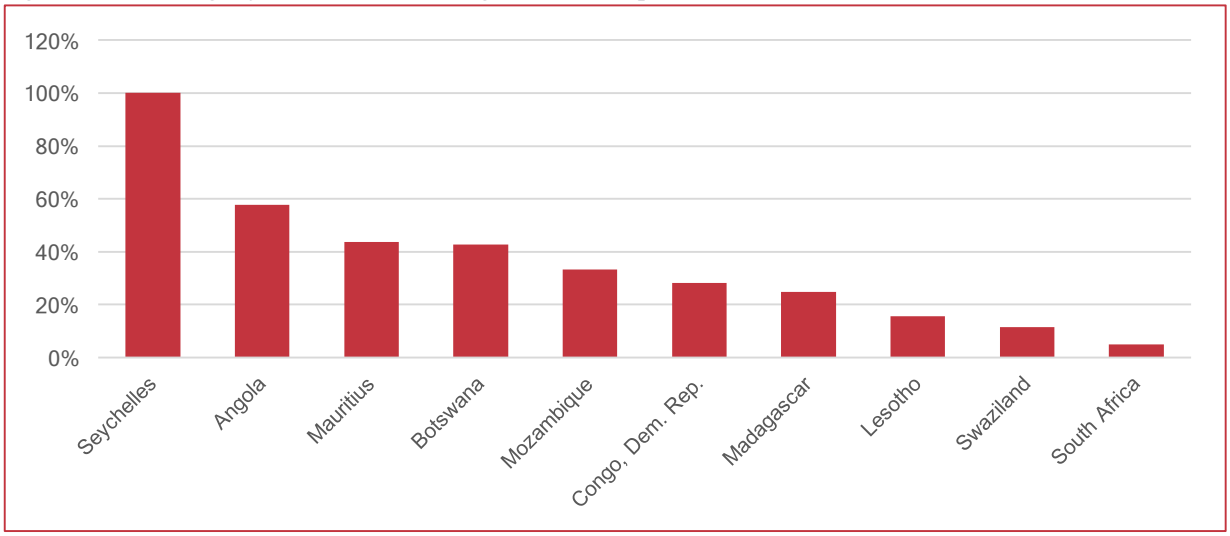
The percentage of enrolment in tertiary education in private institutions is highest in Seychelles – 100% and is also relatively high in Angola, 58%. In South Africa, the percentage of enrolment in tertiary education in private institutions is only 5%, which is the lowest in SSA (see Figure 65).

Figure 64 Enrolment rates – South SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, 2013-2015 (see appendix). Missing data for Namibia and Zambia

Figure 65 Percentage of enrolment in tertiary education in private institutions (%) – South SSA



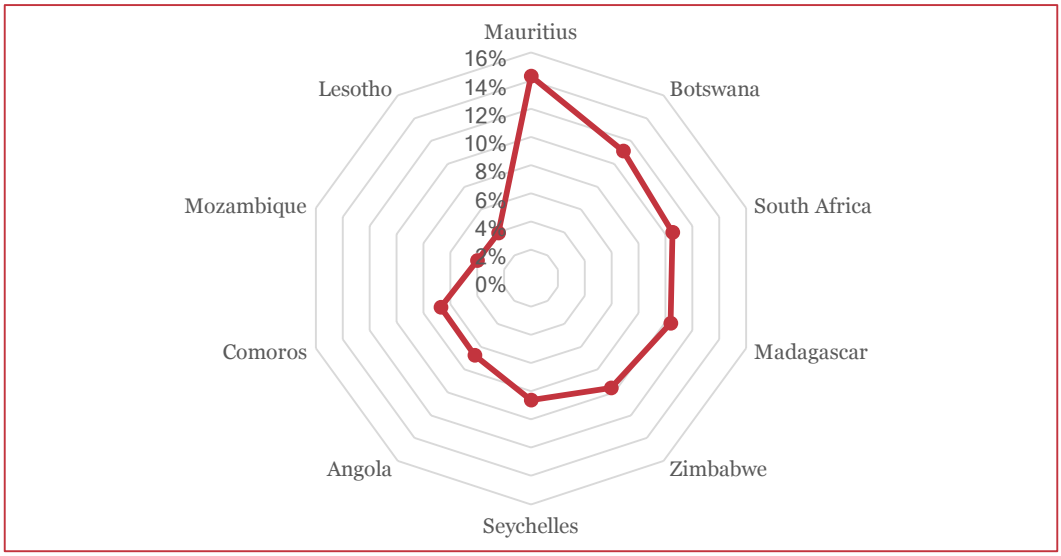
Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, 2012-2015 (see appendix). Missing data for Comoros, Malawi, Namibia, Zambia, and Zimbabwe.

In South SSA, the percentage of graduates from tertiary education graduating from Science programmes are highest in Mauritius (14%), Botswana (11%) and South Africa (11%). The percentage of graduates is only 4% in Mozambique.

The average percentage of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes in Southern SSA is 9%, which is equal to the average estimated for the whole of SSA. The percentage of enrolment in the region is highest in Angola, Zimbabwe and Botswana and is lowest in Seychelles.

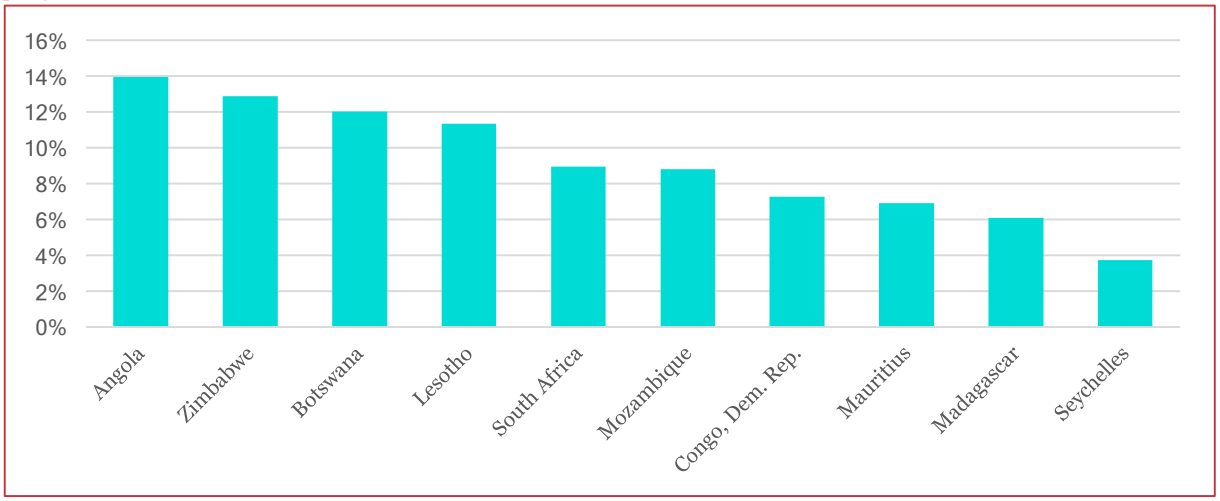
South Africa has a substantial student population enrolled in tertiary Engineering, Manufacturing and Construction programmes, which is close to 93,000. The Democratic Republic of Congo and Angola also have sizeable populations enrolled in tertiary education, Engineering, Manufacturing and Construction programmes: around 32,000 and 31,000 (see Figure 56).

Figure 66 Percentage of graduates from tertiary education graduating from Science programmes, both sexes (%) –South SSA



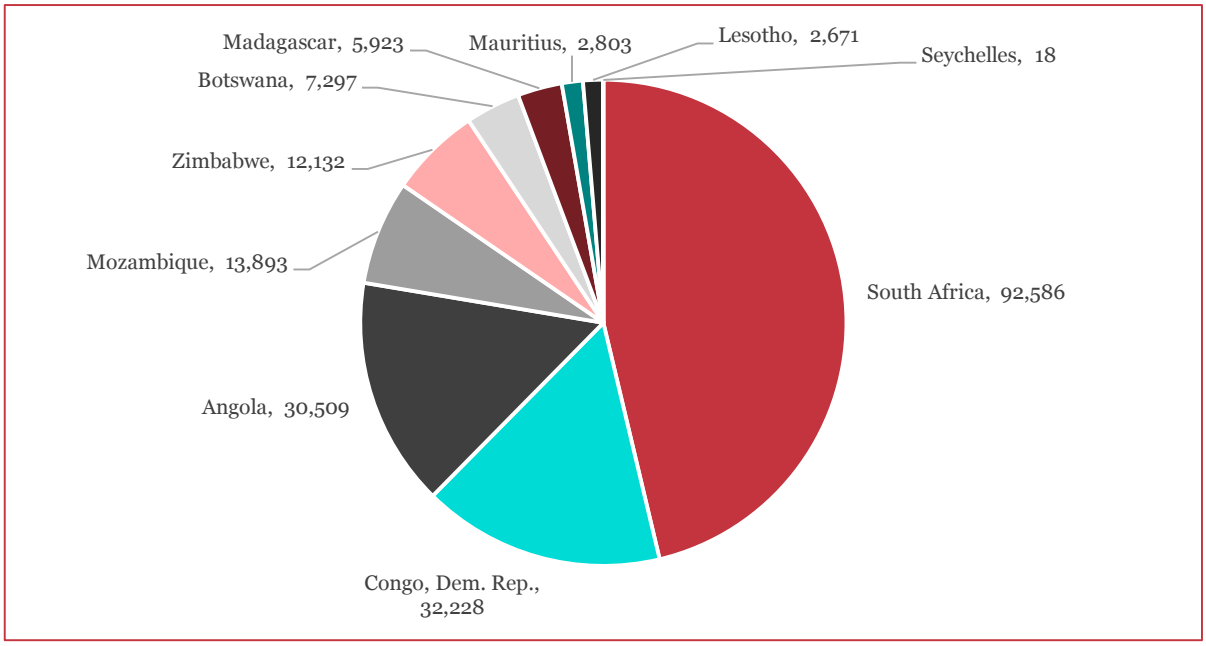
Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, 2013-2014 (see appendix). Missing data for Democratic Republic of Congo, Malawi, Namibia, Swaziland, and Zambia

Figure 67 Percentage of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, both sexes (%) South SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, includes data from 2012-2014. Missing data for Comoros, Malawi, Namibia, Swaziland, and Zambia

Figure 68 Number of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, both sexes. South SSA



Source: Data from Education statistics, World bank, UNESCO Institute for Statistics, includes data from 2012-2014. Missing data for Comoros, Malawi, Namibia, Swaziland, and Zambia

5.3 Key stakeholders

5.3.1 Regional organisations and engineering organisations

South Africa, Zimbabwe, Namibia, Botswana, Lesotho, Swaziland, Mozambique, Seychelles, Zambia, Malawi, and Mauritius are member of SAFEO/FAEO. FAEO is an international organisation that represents the engineering profession and was founded in 1968 with support from UNESCO.

Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Zambia, and Zimbabwe are member of the South African Development Community (SADC).[166] The frontrunner of SADC (SADCC) was established in 1980. Comoros is the only country in South SSA that is not a member of SADC. The objectives of SADC are the, amongst other, to "achieve development, peace and security, and economic growth, to alleviate poverty, enhance the standard and quality of life of the peoples of Southern Africa".[167]

Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Zambia, and Zimbabwe are member of the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEC).[168]

5.3.2 Higher education and research institutions

Table 20 presents an overview of the top 10 universities located in South SSA. All of the Universities are located in South Africa.[169] Also located in South Africa is the African Institute for Mathematical Sciences (AIMS)[170], the Agricultural Research Council[171], and the Council for Scientific and Industrial Research

[166] http://www.sadc.int/

[167] http://www.sadc.int/about-sadc/overview/

[168] http://www.sacmeq.org/

[169] http://www.webometrics.info/en/Africa

[170] https://www.aims.ac.za/

[171] http://www.arc.agric.za/Pages/Home.aspx

(CSIR) in South Africa[172] There are a number of other universities located in South SSA that rank relatively high for SSA, this includes the University of Zimbabwe (Africa rank 39), the University of Botswana (Africa rank 48), the Universidade Eduardo Mondlane, (Africa rank 50), which is located in Mozambique.

Table 20 Top 10 HEIs in South SSA

Country	Africa Rank	World rank	HEI
South Africa	1	323	University of Cape Town
South Africa	2	473	Stellenbosch University
South Africa	3	547	University of the Witwatersrand
South Africa	4	561	University of Pretoria
South Africa	6	652	University of Kwazulu Natal
South Africa	9	855	University of the Western Cape
South Africa	10	985	University of Johannesburg
South Africa	13	1110	Rhodes University
South Africa	15	1248	University of South Africa
South Africa	16	1303	North West University

Source: http://www.webometrics.info/en/Africa

5.3.3 Engineering associations

South Africa, Zimbabwe, Namibia, Botswana, Lesotho, Swaziland, Mozambique, Seychelles, Zambia, Malawi and Mauritius are member of SAFEO. Examples of other engineering associations are presented in the table below.

Table 21 Examples of engineering associations – South SSA

Country	Engineering association	Members	Objectives and Services
Angola	Order of Angolan Engineers (OEA)[173]	Individuals	
Botswana	Botswana Institution of Engineers BIE[174]	Individuals	To promote the advancement of and to facilitate the acquisition of engineering knowledge
Botswana	Association of Consulting Engineers Botswana (ACEB)[175]	Companies	The key objects for which the Association is established are: To promote the advancement of the profession of consulting engineers. To participate in the national and international affairs which affect the profession. To enhance the collective reputation and economic vitality of the Members of the Association. To provide Government, public bodies and others with facilities for conferring with and ascertaining the collective views of consulting engineers.
Comoros			
Democratic Republic of Congo	Association of Aeronautical Engineers and Technicians	Individuals	

[172] http://www.csir.co.za/

[173] http://www.ordemengenheiros.pt/pt/a-ordem/area-internacional/concursos/angola/

[174] http://www.bie.org.bw/

[175] http://www.aceb.org.bw/

Country	Engineering association	Members	Objectives and Services
Democratic Republic of Congo	Congolese Association of Civil Engineers (ACIC)[176]	Individuals	
Lesotho	Lesotho Association of Engineers LAE		
Madagascar			
Malawi	Malawi Institution of Engineers MIE[177]	Individuals	
Malawi	Association of Consulting Engineers of Malawi (ACEM)[178]	Companies	The Association of Consulting Engineers of Malawi (ACEM) brings together companies and firms that provide consulting engineering services in Malawi. Through this association members are able to interact and advance their interests. Government institutions and the private sector are able to solicit views of consulting engineers through this association.
Mauritius	Institution of Engineers, Mauritius IEM[179]	Individuals	To foster engineering science and its application in all engineering disciplines, to ensure the highest standard of service in engineering, and to improve the status and safeguard the interests of the engineering profession.
Mauritius	Association of Consulting Engineers	Individuals	
Mozambique	Order of Engineers (ORDENG)[180]	Individuals	Lead the engineering progress of putting it in the service of national development; register and accredit engineers who wish to practice engineering in Mozambique; ensure compliance with the rules of professional ethics and standards of professional qualification of engineers; defend the interests, rights and prerogatives of its members.
Mozambique	Association of Mozambican Consultancy Companies (AEMC)[181]	Companies	Our main objective is to defend and promote the interests of the Associates, having as our mission the enhancement of excellence and ethics in Mozambican consultancy, by establishing and improving professional skills, business practices and standards, in order to raise the level of competitiveness and business success of its members at national, regional and international levels.
Namibia	Construction Industries Federation of Namibia (CIFN)[182]	Companies	It is the mission of the Construction Industries Federation of Namibia to serve, promote and enhance a prosperous construction industry on behalf of its members in matters of national and international concern and to enhance the quality of life by providing employment and improving skills.
Namibia	Engineering Council of Namibia (ECN)[183]	Professional institutions	Regulates engineering practice
Namibia	The Engineering Professionals Association of Namibia EPAN	Individuals	By 1978, the forthcoming independence of South West Africa / Namibia from the South African colonial regime became a strong prospect. With a view to the regulation of the engineering profession in accordance with the laws of

[176] http://www.acic.cd/
[177] http://www.mie.mw/
[178] http://www.acem.mw/
[179] http://www.iemauritius.com/
[180] http://www.ordeng.org.mz/
[181] www.aemc.org.mz
[182] http://www.cifnamibia.com/
[183] http://www.ecnamibia.org/

Country	Engineering association	Members	Objectives and Services
			an independent Namibia, engineers established EPA to ensure both a continuing high degree of professional competence in the engineering profession and the protection of the interests of the public.
Namibia	Engineering Professions Association Namibia (EPA)[184]		
Namibia	Association of Consulting Engineers of Namibia (ACEN)[185]	Companies	The purpose of ACEN is three-fold. Firstly we represent the best interests of the Consulting Engineers in general towards our clients, very much in the same way as a trade union does for its members. Secondly we represent a direct access route by our clients to our members so that we can aid long term principles such as government policy and the like. Thirdly we provide a structure to which Consulting firms must conform thereby ensuring accountable, responsible and fair practise by all members.
Seychelles	Engineering Institution of Seychelles EIS		
South Africa	South African Institution of Civil Engineering (SAICE)[186]	Individuals	Mission: To advance professional knowledge and improve the practice of civil engineering
South Africa	The Engineering Council of South Africa ECSA[187]	Individuals	The ECSA's vision is to ensure that South Africa enjoys all the benefits of a strong, competent, growing, sustainable and representative Engineering profession; able to provide all the expertise necessary for the socio-economic needs of the country, and to exert a positive influence in South Africa.
South Africa	Association of South African Women in Science and Engineering (SAWISE)[188]	Individuals	The Association of South African Women in Science and Engineering (SA WISE) is a dynamic association for all those who support the idea of strengthening the role of women in science and engineering in South Africa.
South Africa	Consulting Engineers South Africa (CESA)[189]	Companies	CESA represents, for its members, a body which promotes their joint interests and, because of its standing, provides quality assurance for clients.
South Africa	South African Academy of Engineering (SAAE)[190]	Individuals	To promote the technological welfare of the nation by marshalling the knowledge and insights of eminent members of the South African engineering profession, elected by their peers.
South Africa	National Society of Black Engineers, SA (NSBE)[191]	Individuals	The National Society of Black Engineers of South Africa (NSBE) is a voluntary organisation which was established to ensure full participation of black engineers in the mainstream economy, and its wealth creation and distribution within the Republic of South Africa. The NSBE boasts a membership base of over a thousand qualified black engineers (Africans, Indians, Coloureds), and Student Chapters with various institutions of higher learning (Universities and Universities of Technology), and some affiliated companies nationally. Through its collective orientation and national footprint NSBE seek to

[184] http://www.engineers-namibia.org/
[185] www.acen.org.na
[186] http://www.saice.org.za/
[187] http://www.ecsa.co.za/
[188] http://web.uct.ac.za/org/sawise/
[189] http://www.cesa.co.za/
[190] http://www.saae.co.za/
[191] http://www.nsbe.org.za/

Country	Engineering association	Members	Objectives and Services
			continuously identify programmes aimed at achieving its mandate and objectives, through which it partners with various spheres of government, parastatals, and the private sector.
Swaziland	The Swaziland Association of Architects, Engineers and Surveyors SAAES[192]	Individuals	To promote in all their aspects the professions of Architecture, Engineering and Surveying within the Kingdom of Swaziland. To seek the advancements of good management of the professions and maintenance of the highest professional and ethical standards amongst its present and future practitioners.
Zambia	The Engineering Institution of Zambia EIZ[193]	Individuals	
Zambia	Association of Consulting Engineers of Zambia (ACEZ)[194]	Companies	Promoting the interests of Members and Assuring Quality for Engineering Projects in Zambia
Zimbabwe	The Engineering Council of Zimbabwe ECZ[195]	Individuals	To establish an Engineering Council of Zimbabwe and to provide for its functions, power and to provide for the registration and regulation of the practice of Engineers , Technicians and Engineering Firms in Zimbabwe.
Zimbabwe	Zimbabwe Association of Consulting Engineers (ZACE)[196]	Companies	The Zimbabwe Association of Consulting Engineers was formed in 1962 with the prime objective of representing the interests of Consulting Engineers in Zimbabwe.
Zimbabwe	Zimbabwe Institution of Engineers (ZIE)[197]	Individuals	The Zimbabwe Institution of Engineers (ZIE) is a multi-disciplinary Institution covering all aspects of engineering in Zimbabwe.

5.3.4 Employer associations and major employers

Out of the 15 South SSA countries, 13 have employment organisations that are member of the International Organisation of Employers (IOE) – see Table 22. In South Africa, there are various registered employer organisations that are related to the engineering profession. This list of organisations includes:[198]

- Cape Engineers' and Founders Association
- KwaZulu-Natal Engineering Industries Association
- Light Engineering Industries Association of South Africa
- Constructional Engineering Association (South Africa)
- Electrical Engineering and Allied Industries Association
- South African Engineers and Founders Association
- South African Reinforced Concrete Engineers' Association (SARCEA)
- Lift Engineering Association of South Africa
- Eastern Cape Engineering and Allied Industries Association (ECEAIA)

[192] http://www.saaes.org.sz/
[193] http://www.eiz.org.zm/
[194] www.acez.co.zm
[195] http://www.ecz.co.zw/
[196] http://www.zace.co.zw/
[197] http://www.zie.org.zw/
[198] http://www.labourguide.co.za/employer-organisations

- South African Forum of Civil Engineering Contractors (SAFCEC)
- Plumbers and Engineers Brassware Manufacturers' Association
- AD Finem: Construction, Engineering and Allied Employers Organization

Zimbabwe also has employer organisations that are active in the field of engineering, one of these, the Engineering Employers Association, is located in Harare.[199]

Table 22 Overview of employer organisations that are member of the International Organisation of Employers – South SSA

Country	Sector
Angola	Câmara de Comércio e Indústria de Angola (CCIA)
Botswana	Business Botswana
Comoros	
Democratic Republic of Congo	Fédération des Entreprises du Congo (FEC)
Lesotho	Association of Lesotho Employers
Madagascar	Groupement des Entreprises de Madagascar (GEM)
Malawi	Employers' Consultative Association of Malawi (ECAM)
Mauritius	Mauritius Employers' Federation (MEF)
Mozambique	Confederação das Associaçoes Economicas de Moçambique
Namibia	Namibian Employers' Federation (NEF)
Seychelles	
South Africa	Business Unity South Africa
Swaziland	Federation of Swaziland Employers and Chamber of Commerce (FSE & CC)
Zambia	Zambia Federation of Employers (ZFE)
Zimbabwe	Employers' Confederation of Zimbabwe (EMCOZ)

Source: http://www.ioe-emp.org/ioe-members/

In South SSA there are 58 companies in the top 250 Africa Businesses ranking[200] that are active in sectors related to engineering, 55 of these are located in South Africa. The relevant sectors include construction, agribusiness, automobile industry, chemical industry, various transport sectors, and the steel and water industry. In Mozambique, a national electric company is the biggest employer of engineering graduates.[201]

Table 23 Overview of African companies in the top 500 active in engineering related sectors – South SSA

Country	Sector	Company	Turnover ($k)
Mauritius	Air Transport	Air Mauritius	568,291
South Africa	Chemicals	Sasol	17,493,990
South Africa	Telecoms	MTN group	14,969,793

[199] http://www.miningrb.co.zw/business-directory/industry-bodies/employer-organisations/engineering-employers-association.html

[200] http://www.theafricareport.com/top-500-companies-in-africa-2013.html

[201] General Electric has been working with engineering students for the past few years at the Eduardo Mondlane University – scholarships for students USD 250k)

Country	Sector	Company	Turnover ($k)
South Africa	Electricity	Eskom	14,094,823
South Africa	Telecoms	Vodacom group	8,220,220
South Africa	Telecoms	Vodacom South Africa	6,992,388
South Africa	Transport	Transnet	5,637,438
South Africa	ICT	Datatec	5,033,394
South Africa	Telecoms	MTN South Africa	4,740,484
South Africa	Sea transport	Grindrod	4,407,427
South Africa	Telecoms	Telkom	4,062,763
South Africa	Steel	Arcelor Mittal South Africa	3,863,057
South Africa	Construction	Murray & Roberts holdings	3,750,284
South Africa	Rail transport	Transnet Freight Rail	3,396,956
South Africa	Air transport	South African Airways*	3,182,000
South Africa	Elec. Equipment	Allied Electronics corp.	2,894,008
South Africa	Agribusiness	Tiger Brands	2,509,237
South Africa	Telecoms	Blue label Telecoms	2,218,691
South Africa	Agribusiness	Pioneer Foods Group	2,069,901
South Africa	Construction	Wilson Bayly Holmes - OVCON	1,813,638
South Africa	Chemicals	AECI	1,638,382
South Africa	Agribusiness	Tongaat Hulett Group	1,483,788
South Africa	Rail transport	Transnet Rail Engineering	1,383,690
South Africa	Chemicals	Omnia Holdings	1,344,265
South Africa	Elect. Equipment	Reunert	1,341,526
South Africa	Manufacturing	Allied Technologies	1,224,761
South Africa	Construction	Group Five Holdings	1,130,803
South Africa	Agribusiness	Illovo Sugar	1,126,652
South Africa	Construction	Grinaker - LTA	1,087,522
South Africa	Construction	Aurecon Heritage Companies	1,070,008
South Africa	Agribusiness	Rainbow Chicken	1,058,879
South Africa	Agribusiness	Astral Foods	1,056,977
South Africa	Ports	Transnet National Ports Authority	1,014,125
South Africa	Auto dealer	Eqstra Holdings	964,874
South Africa	Automobile	Super Group	962,274
South Africa	Agribusiness	Anglovaal Industries	944,031
South Africa	Auto dealer	Cmh Group	904,228
South Africa	Construction	Massbuild	893,024

Country	Sector	Company	Turnover ($k)
South Africa	Agribusiness	Afgri	866,741
South Africa	Ports	Transnet Port Terminals	866,495
South Africa	Aluminium	Hulamin	854,469
South Africa	Const. Materials	Pretoria Portland Cement Co.	838,369
South Africa	Agribusiness	Clover Holdings	803,528
South Africa	Construction	Basil Read Holdings	765,225
South Africa	Water	Rand Water	723,551
South Africa	Const. Materials	Cashbuild	696,082
South Africa	Automobile	Invicta Holdings	687,726
South Africa	Steel	Evraz Highveld Steel & Vanadium Corp.	686,195
South Africa	Chemicals	African Oxygen	644,314
South Africa	Steel	Trident Steel	627,647
South Africa	Automobile	Bell Equipment	622,794
South Africa	Construction	Raubex	618,107
South Africa	Ict	Pinnacle Technology Holdings	609,196
South Africa	Sea transport	Trencor	570,990
South Africa	Water	Johannesburg Water Co.	567,237
South Africa	Const. Materials	Murray & Roberts Cementation*	536,956
Zimbabwe	Telecoms	Econet Wireless	611,116
Zimbabwe	Automobile	Delta Corp.	554,767

Source: http://www.theafricareport.com/top-500-companies-in-africa-2013.html

5.3.5 National policy makers / agencies, research councils and founding bodies

The ministries that contribute to shaping education and research include ministries of education and ministries of technology. For example:

- South Africa – The Department of Science and Technology and associated minister. The Department of Education (or the former Bantu Education Department) is split into the following:
  - Minister of Basic Education
  - Minister of Higher Education and Training
- Zimbabwe - Ministry of Education, Sport and Culture and the Ministry of Science, and technology Development and the Zimbabwe Council for Higher Education - ZIMCHE (that works on curriculum accreditation)
- Namibia - Ministry of Education
- Mozambique - Minister of Science and Technology

5.4 International schemes and initiatives focusing on South SSA

The following countries, as presented in the tables below, are part of the Africa-EU partnership – Tuning Africa[202]

Table 24 Participants in the Africa-EU partnership – Tuning Africa – South SSA

County	HEI
Angola	Universidade Katyavala Bwila
Botswana	Botho University University of Bostwana
Democratic Republic of Congo	Institut Supérieur de Techniques Appliquées Université Catholique de Bukavu Université de Goma (UNIGOM) Universite de Kinshasa Université de Lubumbashi
Lesotho	National University of Lesotho
Madagascar	University of Antananarivo
Malawi	University of Malawi
Mauritius	University of Mauritius
Mozambique	Universidade Eduardo Mondlane
Namibia	University of Namibia
South Africa	Cape Peninsula University of Technology Universidad de Stellenbosch University of Cape Town University of Kwazulu Natal University of Pretoria University of the Western Cape
Swaziland	University of Swaziland
Zambia	Copperbelt University
Zimbabwe	University of Zimbabwe

Source: http://tuningafrica.org/en/participating-countries/

The following are winners of the 2015-2016 RAEng Africa Prize for Engineering Innovation[203]

- Zimbabwe: MotoCharcoal Briquettes

  "Bio-briquettes are a cooking fuel made from leftover corn stalks and leaves. They provide a clean source of energy that burn with the same calorific value as charcoal, and could help prevent deforestation by reducing the use of charcoal or firewood. Zimbabwe produces about 480,000 tonnes of corn waste every year, from which bio-briquettes can be produced as an affordable and environmentally-friendly energy supply"

- South Africa: Standard Microgrid

  "This innovation is a self-contained, community managed renewable power grid for rural areas. Power generated by a renewable energy source is stored in batteries and distributed to

[202] http://tuningafrica.org/en/participating-countries/

[203] http://www.raeng.org.uk/grants-and-prizes/international-research-and-collaborations/africa-prize/current-and-recent-awards

consumers through the Standard Microgrid. Rather than paying a utility company for electricity by the kilowatt unit, a local Microgrid manger is provided simple tools to manage the grid and distribute subscription credit to community members connected to the grid. Standard Microgrid is able to balance supply and demand to ensure no electricity is wasted and the system is reliable. It does this without needing highly trained personnel to monitor the grid. The system is low-maintenance and robust, which makes it an ideal business model for rural African electrification"

- South Africa: Drylobag

  "The Drylobag is designed to dry and store grain. Wet grain goes mouldy, but the Drylogbag prevents this by reducing the grain temperature and drying it evenly, even in the high humidity typical of Africa's most fertile regions. In doing so, the Drylobag prevents loss of food stocks and enables farmers to harvest earlier. This reduces the risk of weather damage and crops being eaten by wildlife, and helps farmers get crops to market earlier"

6 References

- UNU-MERIT (2015) Policy brief. Innovation for Development in Southern & Eastern Africa: Challenges for Promoting ST&I Policy
- UNECA. Chapter 5. Africa's Science, Technology and Innovation Policies—National, Regional and Continental. http://www.uneca.org/sites/default/files/PublicationFiles/aria7_eng_chap5.pdf
- http://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/East%20Africa%20-%20Rev%20RISP%20.pdf
- Africa's Science and Technology Consolidated Plan of Action (2005). Science and Technology Consolidated Plan of Action (CPA).
- Science, Technology and Innovation Strategy for Africa 2024 http://www.hsrc.ac.za/uploads/pageContent/5481/Science,%20Technology%20and%20Innovation%20Strategy%20for%20Africa%20-%20Document.pdf

7 Data sources

Table 25 Demographic indicators, data sources

Indicator	Source
Population, total	United Nations World Population Prospects
Urban population	World Bank Staff estimates based on United Nations, World Urbanization Prospects
Urban population (% of total)	United Nations, World Urbanization Prospects

Table 26 Economic indicators, data sources

Indicator	Source
GDP (current US$)	World Bank national accounts data, and OECD National Accounts data files
GDP growth (annual %)	World Bank national accounts data, and OECD National Accounts data files
Government expenditure in educational institutions as % of GDP (%)	Data from Education statistics, World bank, UNESCO Institute for Statistics
Internet users (per 100 people)	International Telecommunication Union, World Telecommunication/ICT Development Report and database, and World Bank estimates
World Economic Forum Infrastructure Quality metric (1 = worst, 7 = best).	WEF/CEBR, 2016
Employed engineers as a share of the total population	Data from Eurostat, ILO, Cebr analysis, CEBR, 2016

Table 27 Education indicators, data sources

Indicator	Source
Government expenditure in educational institutions as % of GDP (%)	Data from Education statistics, World bank, UNESCO Institute for Statistics
Percentage of enrolment in tertiary education in private institutions (%)	Data from Education statistics, World bank, UNESCO Institute for Statistics
Gross enrolment ratio, tertiary, both sexes (%)	Data from Education statistics, World bank, UNESCO Institute for Statistics
Gross enrolment ratio, secondary, both sexes (%)	Data from Education statistics, World bank, UNESCO Institute for Statistics
Percentage of students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, both sexes (%)	Data from Education statistics, World bank, UNESCO Institute for Statistics
Percentage of students enrolled in Engineering, Manufacturing and Construction programmes in tertiary education who are female (%)	Data from Education statistics, World bank, UNESCO Institute for Statistics
Percentage of male students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, male (%)	Data from Education statistics, World bank, UNESCO Institute for Statistics
Percentage of female students in tertiary education enrolled in Engineering, Manufacturing and Construction programmes, female (%)	Data from Education statistics, World bank, UNESCO Institute for Statistics

8 Key tables

Table 28 Government expenditure in educational institutions

Country	Government expenditure in educational institutions as % of GDP (%)	Year
Mozambique	7%	2013
Niger	7%	2014
Malawi	6%	2014
South Africa	6%	2014
Ghana	6%	2013
Rwanda	5%	2013
Comoros	5%	2012
Mauritius	5%	2014
Burundi	5%	2013
Cote d'Ivoire	5%	2014
Benin	5%	2014
Ethiopia	4%	2013
Togo	4%	2014
Burkina Faso	4%	2013
Mali	4%	2014
Sao Tome and Principe	4%	2014
Tanzania	3%	2014
Mauritania	3%	2013
Guinea	3%	2013
Cameroon	3%	2013
Chad	3%	2013
Gambia, The	3%	2013
Sierra Leone	3%	2014
Liberia	3%	2012
Lebanon	3%	2013
Guinea-Bissau	2%	2013
Congo, Dem. Rep.	2%	2013
Uganda	2%	2013
Madagascar	2%	2013

Data from Education statistics, World bank, UNESCO.

Table 29 Enrolment

Region	Country	Gross enrolment ratio, secondary, both sexes (%)	Year	Gross enrolment ratio, tertiary, both sexes (%)	Year
West	Cabo Verde	93%	2014	23%	2014
West	Ghana	71%	2015	16%	2014
West	Benin	54%	2014	15%	2013
West	Liberia	38%	2014	12%	2012
West	Guinea	39%	2014	11%	2014
West	Togo			10%	2014
West	Cote d'Ivoire	40%	2014	9%	2014
West	Mali	44%	2014	7%	2012
West	Mauritania	30%	2014	5%	2013
West	Burkina Faso	30%	2014	5%	2013
West	Niger	19%	2014	2%	2012
West	Sierra Leone	43%	2013		
South	Mauritius	98%	2014	39%	2014
South	Botswana	84%	2013	28%	2014
South	South Africa	98%	2013	20%	2013
South	Angola			10%	2013
South	Lesotho	52%	2014	10%	2014
South	Comoros	59%	2013	9%	2013
South	Congo, Dem. Rep.	44%	2014	7%	2013
South	Seychelles	75%	2014	6%	2014
South	Mozambique	25%	2014	6%	2014
South	Zimbabwe	47%	2012	6%	2013
South	Swaziland	63%	2013	5%	2013
South	Madagascar	38%	2014	4%	2013
South	Malawi	39%	2014		
East	Sudan	40%	2012	17%	2013
East	Rwanda	40%	2013	8%	2013
East	Ethiopia	36%	2012	6%	2014
East	Burundi	38%	2014	4%	2013
East	Tanzania	32%	2013	4%	2013
East	Eritrea	36%	2013	3%	2014
East	Kenya	68%	2012		
East	Uganda	28%	2013		

Region	Country	Gross enrolment ratio, secondary, both sexes (%)	Year	Gross enrolment ratio, tertiary, both sexes (%)	Year
Central	Sao Tome and Principe	85%	2015	13%	2015
Central	Congo, Rep.	55%	2012	10%	2013
Central	Chad	22%	2012	3%	2014
Central	Central African Republic	17%	2012	3%	2012
Central	Cameroon	56%	2014		

Source: Data from Education statistics, World bank, UNESCO Institute for Statistics

Table 30 Percentage of graduates from tertiary education graduating from Science programmes, both sexes (%)

Region	Country	Indicator	Year
West	Ghana	11%	2014
West	Burkina Faso	9%	2013
West	Liberia	4%	2012
South	Mauritius	14%	2014
South	Botswana	11%	2014
South	South Africa	11%	2013
South	Madagascar	10%	2013
South	Zimbabwe	10%	2013
South	Seychelles	9%	2014
South	Angola	7%	2013
South	Comoros	7%	2013
South	Mozambique	4%	2014
South	Lesotho	4%	2014
East	Rwanda	11%	2012
East	Sudan	10%	2013
East	Eritrea	9%	2014
East	Burundi	5%	2013

Source: Data from Education statistics, World bank, UNESCO Institute for Statistics

Table 31 Percentage of enrolment in tertiary education in private institutions (%)

Region	Country	Indicator	Year
West	Cabo Verde	57%	2014
West	Cote d'Ivoire	44%	2014
West	Liberia	39%	2012
West	Guinea	35%	2013

Region	Country	Indicator	Year
West	Niger	25%	2012
West	Benin	22%	2013
West	Burkina Faso	21%	2013
West	Ghana	19%	2014
West	Togo	18%	2014
South	Seychelles	100%	2012
South	Angola	58%	2013
South	Mauritius	44%	2014
South	Botswana	43%	2015
South	Mozambique	33%	2014
South	Congo, Dem. Rep.	28%	2013
South	Madagascar	25%	2013
South	Lesotho	16%	2014
South	Swaziland	11%	2013
South	South Africa	5%	2013
East	Burundi	61%	2013
East	Rwanda	56%	2013
East	Tanzania	34%	2013
East	Sudan	23%	2013
East	Ethiopia	13%	2014
Central	Sao Tome and Principe	43%	2014
Central	Congo, Rep.	36%	2013
Central	Chad	28%	2014

Source: Data from Education statistics, World bank, UNESCO Institute for Statistics

Appendix H Timeline of the two pilot EEEP projects

Figure 69 Timeline of the key programme activities

Date	Overall programme milestones	Eastern Africa Hub (Tanzania)		Southern Africa Hub (Zimbabwe)		
		Workshops	Placements	Governance	Workshops	Placements
2012 July	Programme grant awarded					
2013 August	2013.08.01: Formal start of programme					5 secondments from UZ to AAB (1) and ZIMPLATS (4), July-August
2013 Sept			Secondment of 2 academic staff two industry (UDSM)		WS 1 - ZIE Congress: Engineers addressing economic recovery	
2013 Nov			Secondment of 1 industrial fellow (TEMDO) to UDSM	Launch event for project	WS 2 - Research agenda & Secondment feedback seminar 1	
2014 March		WS 1: Development of Competence-Based Curriculum		First Steering Committee meeting	WS 3 - Engineering Experts and Discipline Specific WS (UZ)	Visit to Kariba by UZ assistant lecturers (industry familiarization)
2014 July	Progress report to AAGF					9 secondments from UZ to various industry/government (July-August)
2014 Aug		WS 2: Problem Based Learning (CEDAT)				
2014 Sept			Secondment of 2 academic staff to industry (UDSM)			
2014 Oct					Secondment Feedback Seminar 2 (UZ)	
2014 Nov			Secondment of 1 industrial fellow (TEMDO) to UDSM (same as in 2013)		Visiting fellow seminar (UZ)	Visiting fellow (Mutare) stay (UZ)
				Second Steering Committee meeting	WS 4 - "EEE in Southern Africa"	
2015 Feb		WS 3: Setting Up Best Practices and Processes of Problem-based Incubators (MOI University)				
2015 April				Third Steering Committee meeting	Visiting fellow seminar / WS 5 - EWB Conference - "EEE in Southern Africa"	Visiting fellow (Carter) stay (UZ)

Date	Overall programme milestones	Eastern Africa Hub (Tanzania)		Southern Africa Hub (Zimbabwe)		
		Workshops	Placements	Governance	Workshops	Placements
2015 June						3 secondments from CUT, HIT, UZ to industry (June-August)
2015 July		End of programme conference		Fourth Steering Committee Meeting External evaluation (July-August)	Curriculum Review WS (UZ) End of programme conference	
2015 Aug						
2015 Sept				Fifth Steering Committee Meeting	Africa Engineering Week Conference	
2015 Oct	Final report to AAGF					

WS = Workshop

Appendix I Methodological annex

I.1 Evaluation questions

Figure 70 Main evaluation questions and research methods

Main evaluation questions	Structured interview programme	Desk research	Comparator programme analysis & regional fiches	Surveys – multiple stakeholder groups	Focus groups / workshops
Relevance					
The scope of the engagement	✔	✔✔			
The motivation and experiences of the EEEP industry secondees main employer in being associated with the scheme	✔✔	(✔)		✔✔	✔
Efficiency					
The appropriateness of the financial level and duration of grant made by the Academy	✔✔	✔	✔✔	✔	✔✔
Effectiveness					
The extent to which EEEP secondments and workshops have clear goals, objectives and expectations at the outset and throughout their posting	✔✔	✔✔		✔	✔✔
The effectiveness of current reporting and monitoring mechanisms and the identification of metrics and approaches to assessment that could be used in future	✔✔	✔✔	✔✔		
Results of the programme (outputs, outcomes and impacts)					
A complete list of outputs from the scheme	✔	✔✔		✔	✔
The extent to which EEEP secondees have contributed to technology transfer into industry	✔✔	(✔)		✔	✔✔
The extent to which EEEP secondments and workshops have influenced teaching methods and behaviours within and across the departments of their host institution	✔✔	(✔)		✔✔	✔✔
The impact of EEEP secondments and workshops on students and Higher Education Institute staff	✔			✔✔	✔✔
The extent to which EEEP secondments and workshops have either enriched or influenced the curriculum of engineering courses they have been associated with	✔✔	(✔)		✔✔	✔✔
Whether beneficiaries have increased or intensified the industrial engagement with the institution	✔✔			✔	✔✔
Anecdotal evidence of awardees acting as role models to others	✔	✔		✔✔	✔✔
Any other benefits arising from the schemes	✔✔	✔	✔	✔✔	✔✔
Future considerations					
Consideration of how any scaling of the international programmes can have an embedded UK research link	✔		✔✔		
Consideration of how any scaling of the international programmes will be ODA compliant due to the nature of UK Government spending.	✔		✔✔		

Note: ✔ and ✔✔ indicate, to what extent can the evaluation questions be answered by using the given method

I.2 Document review

Figure 71 List of documents reviewed for the evaluation

Document	Programme
Proposal: Tertiary Education programme in Sub-Saharan Africa, the Royal Academy of Engineering, 2012	EEEP
Budget for education proposal - 2 unis - 2 years – PROPOSAL	EEEP
Budget for education proposal - per hub university - PROPOSAL	EEEP
Enriching Engineering Education Programme Brochure, Royal Academy of Engineering	EEEP
Progress report to the Anglo-American Group Foundation - July 2014	EEEP
Final report to the Anglo-American Group Foundation - October 2015 Final	EEEP
Steering Group Meeting: EEEP, Friday 26 February 2016	EEEP
Notes from visit to Zimbabwe and Tanzania, Royal Academy of Engineering, November 2013	EEEP
Notes from EEEP final conference, Royal Academy of Engineering, July 2015 (1)	EEEP
Notes from EEEP final conference, Royal Academy of Engineering, July 2015 (2)	EEEP
Enriching Engineering Education Programme: Phase 2 guidance notes, Royal Academy of Engineering	EEEP
Memorandum of Agreement between The Royal Academy of Engineering and the University of Dar es Salaam	EEEP (Eastern Hub)
Implementation Plan for College of Engineering and Technology	EEEP (Eastern Hub)
2 Year Project Budget for the HEIs Hub – College of Engineering and Technology	EEEP (Eastern Hub)
"Monitoring and Evaluation-Appendix 1-2-3-4: Expenditure for 4 Phases"	EEEP (Eastern Hub)
Progress Report on The Implementation of Enriching Engineering Education Programme in Sub-Sahara Region, Prof. B.B. Nyichomba, 29th January 2014	EEEP (Eastern Hub)
Narrative Repot for the First and Second Phases of the EEEP, 3rd July 2014	EEEP (Eastern Hub)
Final Report of EEEP, August 2015	EEEP (Eastern Hub)
Proposed Agenda: Workshop on Development of Outcome Based Curriculum for Higher Education Institutions in Sub-Saharan Africa	EEEP (Eastern Hub)
Report from the 1st Stakeholders Consultative Workshop: Development of the Outcome Based Curriculum, 24th May 2014	EEEP (Eastern Hub)
Time Table: The 2nd Workshop on Problem-Based Learning: A Teaching and Learning Tool for Enhancing Innovation Capacity in EAC Higher Education Engineering Institution	EEEP (Eastern Hub)
Report from the 2nd Stakeholders Consultative Workshop: Problem Based Learning: A Teaching and Learning Tool for Enhancing Innovative Capacity in EAC Higher Education Engineering Institutions, 7th to 8th August 2014, B. B. Nyichomba, 20th August 2014	EEEP (Eastern Hub)
"Submission of the Final EEEP Report, Proceedings of 3rd Workshop and Expenditure for the Programme as from August 2013 to July 2015", Correspondence	EEEP (Eastern Hub)
Report from the 3rd Stakeholders' Consultative Workshop: Setting Up Best Practices and Processes of Problem-based Incubators in EAC Higher Learning Institutions, 10th March 2015	EEEP (Eastern Hub)
Industrial Secondment Report for Dr Richard Kimwaga at Poyry Tanzania Limited, October 2013	EEEP (Eastern Hub)
"Report After Secondment to Tanzania Engineering and Manufacturing Design Organization (TEMDO), Arusha, Tanzania", Dr Tito E. Mwinuka	EEEP (Eastern Hub)

Document	Programme
Report on Placement of Eng. Kalutu P.R. Koshuma of TEMDO to CoET, 18TH November to 17 TH December, 2013	EEEP (Eastern Hub)
Industrial Follow Placement at CoET: Report on Second Placement of Eng. Kalutu P.R. Koshuma of TEMDO at CoET, 1st to 30th November 2014	EEEP (Eastern Hub)
"Design Methodology – Case study: Project/Product Identification", Presentation	EEEP (Eastern Hub)
"Design Methodology – Case study: Design and Development of Medical Solid Waste Incinerator", Presentation	EEEP (Eastern Hub)
PD 305: Design Project I 2013/2014 – Design of an Elbow Crutch for Disabled People	EEEP (Eastern Hub)
"Design, Development and Commercialization of a Medical Solid Waste Incinerator", Seminar Presentation, Eng. Kalutu Koshuma, 11th December 2013	EEEP (Eastern Hub)
Memorandum of Agreement between the Royal Academy of Engineering and the University of Zimbabwe	EEEP (Southern Hub)
Enriching Engineering Education in Southern Africa: Implementation Plan 2013-2015, University of Zimbabwe	EEEP (Southern Hub)
Enriching Engineering Education in Southern Africa: Biannual Report [August 2013 to January 2014], University of Zimbabwe, January 2014	EEEP (Southern Hub)
Enriching Engineering Education in Southern Africa: Biannual Report 2 [February 2014 to July 2014], University of Zimbabwe, July 2014	EEEP (Southern Hub)
Enriching Engineering Education in Southern Africa: Biannual Report 3 [August 2014 to January 2015], University of Zimbabwe, January 2015	EEEP (Southern Hub)
Enriching Engineering Education in Southern Africa: Biannual Report 4 [February 2015 to July 2015], University of Zimbabwe, July 2015	EEEP (Southern Hub)
"Final Report for End of Team Evaluation: Enriching Engineering Education in Southern Africa Zimbabwe", Report of the Evaluation Team Continental Resources Network (Private) Limited t/a CRN Consultants, 1st September 2015.	EEEP (Southern Hub)
Notes from Fourth steering group committee meeting for RAEng EEEP, 23rd July 2015	EEEP (Southern Hub)
Programme for Enriching Engineering Education in Southern Africa: Details of workshops hosted under the project	EEEP (Southern Hub)
Workshops Programme: Faculty of Engineering Research Agenda, November 2013, University of Zimbabwe	EEEP (Southern Hub)
Report on Curriculum Review Workshop, held on 20th July 2015, University of Zimbabwe Faculty of Engineering	EEEP (Southern Hub)
Frank Kavishe: "Perspectives of Enhancing Engineering Education in Developing Countries", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
Nyemba (et al.): "Innovative Strategies to Enrich Engineering Education in Southern Africa", Paper	EEEP (Southern Hub)
Papers presented by RAE Project participants at the SAFEO Conference	EEEP (Southern Hub)
Mercy Manyuchi: "HIT in Engineering Education", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
D A Mashauri: "Research Focus Areas for the School of Engineering", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
Z B Dlodlo: "Experiences in Practical Research: NUST, Faculty of Industrial Technology", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)

Document	Programme
E. Manyumbu: "Chinhoyi University of Technology: Experiences in Practical Research", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
Zacarias Chilengue: "Engineering Education in Southern Africa", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
Edward Dintwa: "Experiences in Practical Research", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
T. P. Masarira: "Experiences in Practical Research: Faculty of Engineering, University of Zimbabwe", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
Gertjan van Stam: "Experience in Research and Development in (rual) Africa: Towards an African Expression of Technology", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
Nesbert Mutare: "Latest Trends and Developments in Engineering Technology in Industry: How can HEIs keep with the pace to remain relevant?", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
Frank Kavishe: "Incorporating Pratical Experience into Teaching and Research", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
Fernando does Santos: "Patenting", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
Langworthy: "Brand Power", Presentation at Workshop on Enriching Engineering Education in Southern Africa, Harare 6th-7th November 2014.	EEEP (Southern Hub)
Nyemba, Carter and Mbohwa: "Engineering a better world: Collaborations for capacity building and sustainability - the case of the United Kingdom and Southern Africa", draft paper.	EEEP (Southern Hub)
Programme for Enriching Engineering Education in Southern Africa: Details of staff secondments to industry	EEEP (Southern Hub)
"Visiting Fellow Programme: Report on the Visit to the Univesity of Zimbabwe – Faculty of Engineering Period 2 November 2014 to 15 November 2014", Nesbert Mutare, December 2014	EEEP (Southern Hub)
"University of Zimbabwe, Faculty of Engineering: Educational and Research Review", Keith Carter, April 2015.	EEEP (Southern Hub)
IAPP List of Approved Project – External, Royal Academy of Engineering	IAPP
Industry Academia Partnerships: Logframe, Royal Academy of Engineering	IAPP
Internal Programme Design Template (Grant Funding)	IAPP
Industry Academia Partnership Programme (IAPP): Request for Proposal	IAPP
Quarterly Report, Project Reference #IAPP151682, June 17th 2016	IAPP (Colombia)
Newton-Bhabha Innovation Workshop Report	IAPP (India)
2015 Industry Academia Partnership Programme Reviewer Guidance Notes, Royal Academy of Engineering	IAPP (India)
Quarterly Report, Project Reference # HEPI\1516\02, June 11th 2016	IAPP (India)
Quarterly Report, Project Reference #Ref: No. HEPI\1516\31 dt. 17 March 2016	IAPP (India)
Quarterly Report, Project Reference HEP1516-11, 16th June 2016	IAPP (India)
Quarterly Report, [no reference #], [no date]	IAPP (India)
Quarterly Report, Project Reference # HEPI\1516\27, 16th June 2016	IAPP (India)

Document	Programme
Quarterly Report, Project Reference # HEPI\1516\25, 15th June 2016	IAPP (India)
Quarterly Report, Project Reference # HEPI\1516\49, [no date]	IAPP (India)
Quarterly Report, Project Reference # HEPI\1516\37, 17th June 2016	IAPP (India)
Quarterly Report, Project Reference # HEPI\1516\41, 17th July 2016	IAPP (India)
Quarterly Report, [no reference #], 7th June 2015	IAPP (India)
Quarterly Report, Project Reference # HEPI/1516/16, [no date]	IAPP (India)
Industry Academia Partnership Programme (IAPP): Request for Proposal	IAPP (Kazakhstan)
Guidance Notes: Industry Academia Partnership Programme	IAPP (Kazakhstan)
Quarterly Report, [no reference #], [no date]	IAPP (Kazakhstan)
Quarterly Report, Project Reference # IAPP\1516\61, 17th June 2016	IAPP (Kazakhstan)
Quarterly Report, Project Reference # IAPP\1516\27, 16th June 2016	IAPP (Kazakhstan)
Quarterly Report, [no reference #], 16th June 2016	IAPP (Kazakhstan)
Higher Education Partnership Models for South Africa: Outcomes and Proposals	IAPP (South Africa)
Guidance Notes: Industry Academia Partnership Programme, Thailand	IAPP (Thailand)
Industry Academia Partnership Programme (IAPP) – Thailand: Request for Proposal	IAPP (Thailand)
Quarterly Report, Project Reference # IAPP/1516/135, 2nd June 2016	IAPP (Thailand)
PROGRESS REPORT: IAPP151633 - Advanced reader model for magnetic recording via multiscale approach, June 2016	IAPP (Thailand)

I.3 Overview of the survey results - EEEP Hub and spoke university staff and workshop participant survey

Question 1 - Please provide the following information about yourself and your organisation

Figure 72 Basic information of the respondents

Options	Response Percent	Nr of responses
Name	100.0%	28
Country of residence	100.0%	28
Name of your Higher Education Institute	100.0%	28
Your position (e.g. dean, Professor, researcher)	100.0%	28
Total		**28**

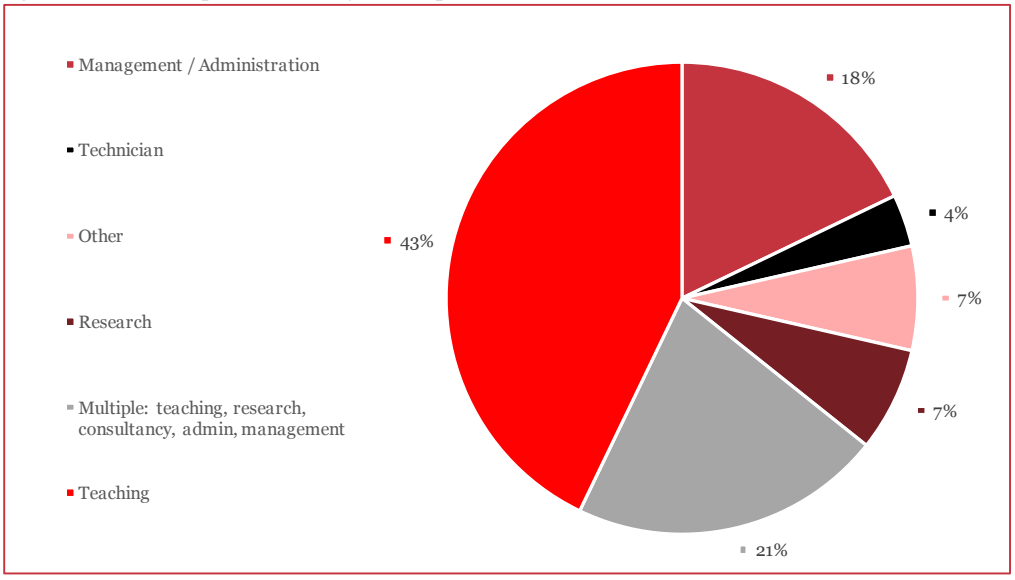
Figure 73 Country of residence, name of HEI, position of the respondents

Country of residence	Name of your Higher Education Institute	Your position (e.g. dean, Professor, researcher)
Uganda	Makerere University	Software engineers, graduate student

Country of residence	Name of your Higher Education Institute	Your position (e.g. dean, Professor, researcher)
Zimbabwe	National University of Science and Technology (NUST)	Lecturer/Chairperson
Kenya	Moi University	Professor
Zimbabwe	University of Zimbabwe	Administrator
Tanzania	University of Dar es Salaam	Deputy Principal
Zimbabwe	Midlands State University, Manicaland College of Applied Sciences	Acting Departmental Chairperson
Tanzania	UDSM	Instructor
Zimbabwe	Chinhoyi University of Technology	Lecturer
Tanzania	University of Dar es Salaam	Assistant Lecturer
Zimbabwe	University of Zimbabwe	researcher
Uganda	Makerere University	Ag. Head of Department
Tanzania	University of Dar es Salaam	Lecturer
Tanzania	University of Dar es Salaam	Researcher
South Korea	University of Seoul	PhD student
Zimbabwe	University of Zimbabwe	Lecturer
Tanzania	University of Dar es Salaam	Principal Administrative Officer
Zimbabwe	University of Zimbabwe (UZ)	Researcher & Lecturer in Mining Engineering
Botswana	Botswana International University of Science and Technology	Lecturer
Zimbabwe	University of Zimbabwe	Senior Chief Technician
Zimbabwe	University of Zimbabwe	Staff development fellow
Zimbabwe	University of Zimbabwe	Senior Lecturer
Zimbabwe	Chinhoyi University of Technology	Chairman of Department
Zimbabwe	University of Zimbabwe	Head of Department
Zimbabwe	University of Zimbabwe	Lab technician
Zimbabwe	University of Zimbabwe	Faculty Industrial Liaison officer
Zimbabwe	University of Zimbabwe	Lecturer
Tanzania	University of Dar es Salaam	Senior Lecturer
Kenya	Moi University	Associate Professor

Question 2 - Please select your main responsibilities in your current position. Please tick all that apply.

Figure 74 Main responsibilities of the respondents (n=28)



Other includes:

- Studying for a master's degree
- Engineering Instructor /Liaison Officer

Question 3 - How did you hear about the EEEP?

Free text entered, n=28

Question 4 - Why did you get involved in the EEEP? Please describe your motivation for participating in the project

Free text entered, n=26

Question 5- Could you please indicate how useful did you find the different project activities, in which you participated?

Figure 75 Usefulness of the different programme activities (n=27)

	Highly useful	Somewhat useful	Not useful at all	I did not participate in this activity	Nr. of responses
Workshop(s) organised as part of the EEEP project	26	0	0	1	27
Seminars or lectures held by visiting fellows from industry	17	5	0	5	27
Interaction with visiting industry fellow(s) during their stay	14	7	0	5	26
Feedback seminar with university staff returning from secondments	14	9	0	5	27
Exchange of experience with staff returning from secondment	14	5	1	7	27
Informal discussions with colleagues about project activities	12	11	0	4	26

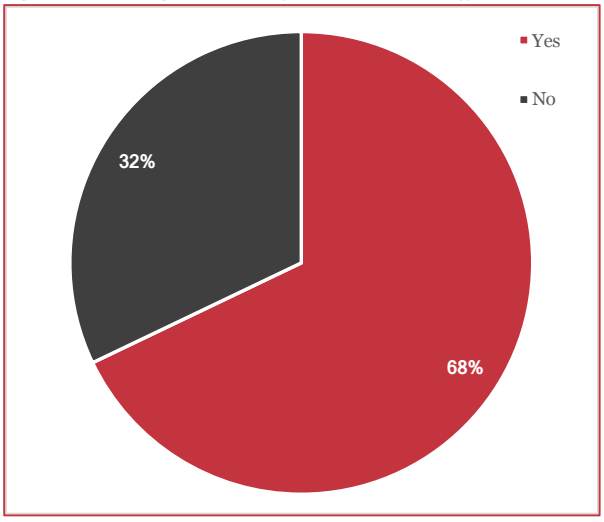
Other activities (e.g. joint projects), please specify below	3	4	1	11	19
Other activities (e.g. joint projects), please specify					**4**
Total number of responses					**27**

Question 6 – Please provide any further comments you might have.

Free text entered, n=19

Question 7 - Do you find that your level of involvement in the project activities was sufficient?

Figure 76 Was your level of involvement sufficient (n=28)



Question 8 - Did you participate in one or more workshops?

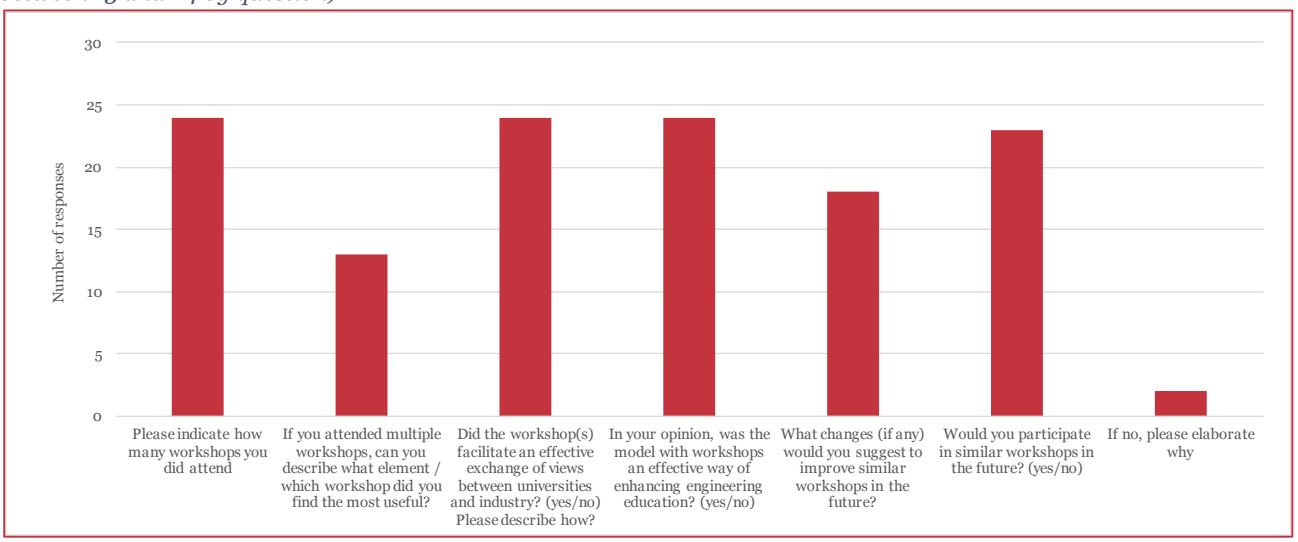
Figure 77 Did you participate in one or more workshops (n=28)

	Response Percent	Number of responses
Yes	96%	27
No	4%	1
Total		**28**

Question 9 - Please answer the following questions regarding your experience with the workshop(s)

Free text entered to the different sub-questions, the number of responses are presented in the chart below

Figure 78 Please answer the following questions regarding your experience with the workshop(s) (n varies between 13 and 24 by question)



Question 10 – Please indicate your agreement with the following statements in relation to your participation in the workshop(s)

Figure 79 Please indicate your agreement with the following statements in relation to your participation in the workshop(s)

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Number of responses
I have learnt new tools or methods that I can use at work	7	14	3	0	0	24
I have changed the teaching methods that I use in my classes	2	17	4	0	0	23
I have changed the content/curriculum of the classes that I teach	2	9	9	3	0	23
I have changed my approach to university-industry collaboration	7	14	3	0	0	24
I have established new contacts with other universities / industrial partners	8	12	3	1	0	24
Please provide any comments you may have	0	5	2	0	0	7
Please provide comments						10
Total						**24**

Question 11 - Please indicate your agreement with the following statements in relation to your institutions' participation in EEEP

Figure 80 Please indicate your agreement with the following statements in relation to your institutions' participation in EEEP

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Number of responses

The faculty or department has changed curricula for engineering courses	5	5	12	1	1	24
The faculty or department has given new guidelines or instructions regarding teaching methods (e.g. more practical student projects and teamwork)	6	10	7	1	0	24
The faculty or department has increased its emphasis on collaboration with industry	8	12	3	1	0	24
The faculty has created new support structures to facilitate collaboration with industry	5	9	8	2	0	24
Please provide details on any other ways in which your department or faculty has benefited from participation in the programme	2	4	4	0	0	10
Total						***24***

Question 12 - Please describe any other effects that participation in the Enriching Engineering Education Programme has had on your institution and on your students

Free text entered, n=14

Question 13 – We would like to hear your suggestions to improve similar projects in the future

Figure 81 Suggestions for similar projects in the future

	Response Percent	Number of responses
What changes (if any) would you suggest to improve similar projects in the future?	77.3%	17
What type of support, guidance would be needed to maintain the results and enhance the impact of the project?	100.0%	22
What type of institutions would be best placed to take advantage of the programme in the future?	95.5%	21
Total		**22**

Question 14 - Do you have any other comments or recommendations?

Free text entered, n=18

I.4 List of interviewees consulted during the evaluation

Figure 82 below lists the individuals interviewed or consulted for this evaluation.

Figure 82 Interviewees

Name	Position	Institution	Country
Dr Henry Alinaitwe	Principal of the College of Engineering, Design, Art and Technology	Makerere University	Uganda
Tim Askew FREng	Managing Director	ATS Management	United Kingdom

Name	Position	Institution	Country
Dr Ekua Bentil	Education Specialist	World Bank	United States
Prof M.N. Bergendahl	Vice President for Collaboration	Royal Institute of Technology in Stockholm	Sweden
Prof David Bogle FREng	Vice Provost for Research	University College London	United Kingdom
Keith Carter	Visiting Professor	University of Leicester	United Kingdom
Dr Zacharias Chilengue	Deputy Dean for under-graduation, Faculty of engineering	Universidade Eduardo Mondlane	Mozambique
Mr Simon Chinguwa	Lecturer	University of Zimbabwe	Zimbabwe
Dr Mona-Lisa Dahms	UNESCO Chair - Problem Based Learning	Aalborg university	Denmark
Mr A Danda	Teaching Assistant	University of Zimbabwe	Zimbabwe
Dr Sanzan Diarra	Chief Executive officer	Zimbabwe Institution of Engineers	Zimbabwe
Prof Edward Dintwa	Professor	University of Botswana	Botswana
Mr Fernando Dos Santos	Director General	African Regional Intellectual Property Organization (ARIPO)	Zimbabwe
Ms Meredith Ettridge	International Policy Advisor	Royal Academy of Engineering	United Kingdom
Mr J Gava	Technician, Geoinfo. and Surveying	University of Zimbabwe	Zimbabwe
Prof Peter Goodhew, FREng	Emeritus Professor of Engineering	University of Liverpool, School of Engineering	United Kingdom
Dr Matheo L. Raphael Isingo	Senior lecturer, Manager of Technology Development and Transfer Centre	University of Dar es Salaam	Tanzania
Mr P Janaso	Technician	University of Zimbabwe	Zimbabwe
Prof. Samuel John	Dean, Faculty of Engineering	Namibia University of Science and Technology (formerly Polytechnic of Namibia)	Namibia
Musa Sedama Kamata	Project Coordinator	Buni - Incubator and Entrepreneurship Centre	Tanzania
Prof Frank Kavishe	Dean, Faculty of Engineering	University of Namibia	Namibia
Dr Richard Kimwaga	Senior Lecturer	University of Dar es Salaam	Tanzania
Dr. Sam Muchina Kinyanjui	Director of IDeAL and Head of Training	KEMRI Wellcome Trust	Kenya
Mr L. Madakuenda	Technician	University of Zimbabwe	Zimbabwe
Mr A Madzivire	Technician	University of Zimbabwe	Zimbabwe
Dr Dugushilu Mafunda	Director, Centre for Development and Transfer of Technology	Tanzania Commission for Science and Technology (COSTECH)	Tanzania
Dr Hodson Makurira	Dean of Faculty	University of Zimbabwe	Zimbabwe
Mr T Makwangudze	Catchment Manager	Zimbabwe National Water Authority (ZINWA)	Zimbabwe
Eng M Manuhwa	Chairman	Engineering Council of Zimbabwe	Zimbabwe

Name	Position	Institution	Country
Mr W R Manyota	Senior Technician, Electrical Workshops	University of Zimbabwe	Zimbabwe
Eng Dr. M Manyuchi	Lecturer, Head of Chemical Engingeering Processing	Harare Institute of Technology	Zimbabwe
Eng. Dawson Z Mareya	Managing Director	Mazda - Willowvale Motors Industries	Zimbabwe
L M. Masaiti	Technician	University of Zimbabwe	Zimbabwe
Mr H Masanganise	Technician / Engineering instructor	University of Zimbabwe	Zimbabwe
Prof Damas Mashauri	Head of Department, Civil and Environmental Engineering	Namibia University of Science and Technology (formerly Polytechnic of Namibia)	Namibia
Mr James Matsika	Human Resources	Zimbabwe Platinum Mines (ZIMPLATS)	Zimbabwe
Mr Petter Matthews	Director	Engineers Against Poverty	United Kingdom
Mr Joseph Mavengere	Lecturer	Chinhoyi University of Technology	Zimbabwe
Ms Eng. Diana Mbogo	Former student of engineering	University of Dar es Salaam	Tanzania
Eng Ali Mkamba	Executive Director	Association of Consulting Engineers Tanzania (ACET)	Tanzania
Eng Steven D. Mlote	Registrar/Secretary	Engineers Registration Board (ERB)	Tanzania
Gemma K.G. Modu	Director - Information, Research & Planning	The National Council for Technical Education (NACTE)	Tanzania
Eng Peter Morris	Board Member	Zimbabwe Association of Consulting Engineers (ZACE)	Zimbabwe
Mr D Moyo	Technician	University of Zimbabwe	Zimbabwe
Mr Ngwisa W. Mpembe	Managing Director	Lahmeyer Tanzania	Tanzania
Dr. Hassan Mshinda	Director General	Tanzania Commission for Science and Technology (COSTECH)	Tanzania
Eng S Mudzviti	Technician	University of Zimbabwe	Zimbabwe
Mr Tawanda Mushiri	Lecturer, Mech. Engineering	University of Zimbabwe	Zimbabwe
Mr Nesbert M Mutare	General Manager/CEO	Buchwa Iron Mining Company	Zimbabwe
Mrs Susan Muzite	Executive Director	Research Council of Zimbabwe	Zimbabwe
Dr Tito Mwinuka	Head, Department of Mechanical and Industrial Engineering	University of Dar es Salaam	Tanzania
Eng. W R Nyemba	Senior Lecturer (former Dean)	University of Zimbabwe	Zimbabwe
Prof. Bavo B. Nyichomba	Associate Professor	University of Dar es Salaam	Tanzania
Eng Benjamin Rafemoyo	Chief Executive Officer	Engineering Council of Zimbabwe	Zimbabwe
Mr Liam Roberts	Programme officer	The Association of Commonwealth Universities	United Kingdom
Mr Sebastian Scott	Programme Officer	Royal Academy of Engineering	United Kingdom
Mr Shaarad Sharma	Programme Manager, IAPP	Royal Academy of Engineering	United Kingdom

Name	Position	Institution	Country
Dr Hayaatun Sillem	Director of Strategy and Deputy CEO	Royal Academy of Engineering	United Kingdom
Dr S. Simiyu Sitati	Dean of School of Engineering	Moi University	Kenya
Prof Abraham K. Temu	Director, Innovation and Entreprenurship Centre	University of Dar es Salaam	Tanzania
Dr Eng Michael James Tumbare	Senior Lecturer	University of Zimbabwe	Zimbabwe
Prof. Paul Wambua	Deputy Vice-Chancellor	Dedan Kimathi Universty of Technology	Kenya
Mr J D Zibagwe	Technician	University of Zimbabwe	Zimbabwe

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