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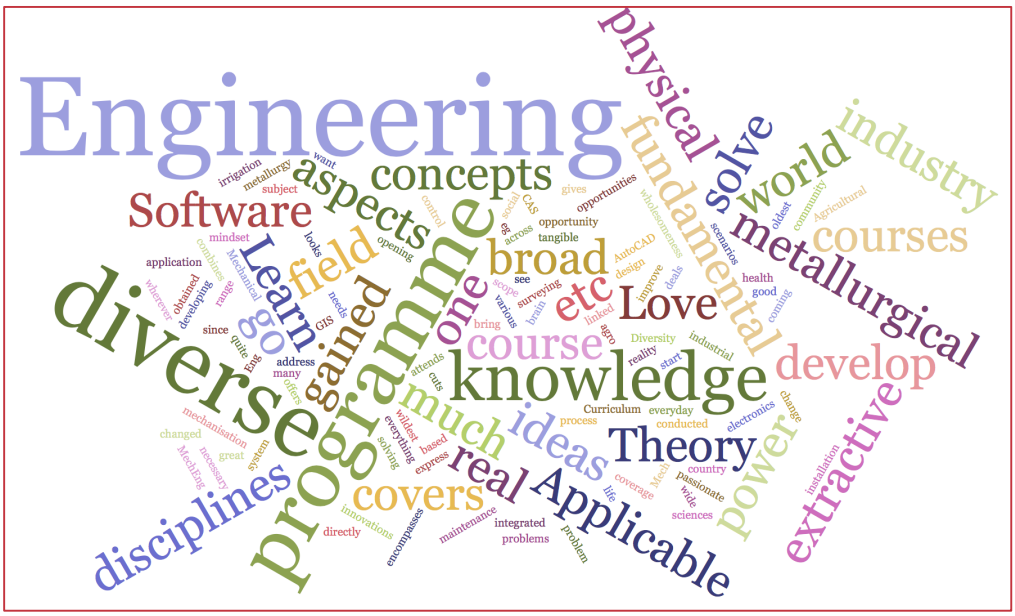
16 December 2016

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

Final report



Source: Discussion with students about what they like about engineering

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Executive Summary

This report provides the findings of the Evaluation of the Enriching Engineering Education Programme (EEEP) in the context of the Academy's International Industry-Academia Linkage Programmes. The evaluation was commissioned by the Royal Academy of Engineering and carried out by Technopolis Ltd between August and November 2016.

The evaluation's overall objective was to assess and where possible quantify the extent to which the EEEP has been effective and represents value for money for the Academy. It further aimed to provide guidance for the design and implementation of an upscaling of the programme and the Academy's international industry-academia programmes more broadly.

The Enriching Engineering Education Programme

The EEEP was designed to address the engineering 'skills gap' in Sub-Saharan Africa, an important factor in holding back economic development in the region. The EEEP aimed at improving engineering curricula and teaching methods, enhancing the skills and employability of engineering graduates, developing sustainable relationships between universities and industry, and creating networks of engineering departments at universities in Sub-Saharan Africa. The programme used two-way staff exchanges between academia and industry and dissemination and knowledge sharing workshops engaging higher education institutions and broader stakeholders as core activities to achieve its objectives.

The EEEP was implemented using a 'hub and spoke' model. During the pilot projects two institutions – the University of Dar es Salaam (Tanzania, Eastern Africa) and the University of Zimbabwe (Southern Africa) – acted as 'hubs' responsible for the management and delivery of main project activities. They each led a consortium with several 'spoke' institutions from the surrounding region that participated in programme events and benefitted from knowledge shared by the hubs. The two pilot projects received £140k funding for the two year-long implementation.

Relevance of the programme

The **aims and objectives** of the EEEP were - and still are - seen as **highly relevant** by all stakeholders consulted. There is a shared recognition of the need for change and clear understanding of the strengths and weaknesses of the current procedures and systems. Among the most important needs identified by the stakeholders are better trained graduates, increased relevance of the curriculum to industry, upskilling of university staff, better access to equipment and improvement of the quality of education in line with international standards. Engineering students are aware of the importance of problem-based learning, access to up-to-date equipment, the development of 'soft skills' and entrepreneurial mind-set.

Project **participants** were very **motivated and enthusiastic** about the EEEP. Each group of participants had realistic expectations considering their respective roles. The hubs' motivations reflected well on the overall programme objectives, whereas spoke universities primarily saw their participation as an opportunity to learn about new practices and teaching methods through discussion and experience exchange. For seconded university staff, the programme offered an **unprecedented opportunity to acquire industry-relevant knowledge** and to give back to industry.

Among **industrial partners**, there was a **recognition of their role and responsibility** in contributing to upskilling teaching staff, discussing mutual expectations and needs as well as providing resources to make this possible. Ultimately, there is a long-term pay-off for industry if they can ensure that the graduates are highly skilled and require less on-the-job training.

Efficiency and effectiveness

The two programme hubs were allowed a large degree of flexibility in the projects, which allowed for **tailoring the implementation in line with the local needs**. This however resulted in the two hubs

emphasising different activities, which in return delivered somewhat different outcomes. **Both hubs met the headline output targets** for the programme, each carrying out at least two secondments of university staff to industry, hosting one visiting fellow from industry at the hub university and organising four workshops. The Southern African hub significantly overachieved in this respect, delivering 17 secondments and seven workshops in addition to other activities.

The original programme design foresaw rather peripheral involvement of the spokes, but some of the spoke universities took on a larger role, especially in the Eastern hub. Still, spoke universities expressed **strong interest in having more active engagement** in any future project activities.

The benefits of **workshops were widely appreciated**, providing a unique opportunity to meet and build networks. The long-term sustainability of these contacts in the absence of follow-up activities remains uncertain. **Secondments** resulted in numerous benefits to the individual secondees and **were highly valued by all stakeholders**. There is however **room for increased dissemination** and more interaction among the various project activities to enhance the spill-over effects.

The **project activities serve different purposes**, and their use should be aligned with the intended results. The estimated cost of secondments (1,000$-5,000$ month/person), visiting professors from industry ($5,000 month/person) and workshops ($250-700 per person per workshop) and staff training ($200-300 per person) might not in all cases be proportionate to the benefits. Any decision to investment in these activities should consider how they combine to contribute to achieving the objectives, and what follow-up activities are needed to ensure that benefits are realised and sustained.

The duration of the programme was short considering the desired cultural and institutional changes needed to achieve the programme's high level objectives. An **extended timeframe** of 3-5 years **would allow for greater flexibility** to align project implementation to the changing needs and provide the opportunity to carry out necessary follow-up actions to ensure sustainability of the results. Appropriate programme design and monitoring could mitigate the risks inherent in a longer programme span.

The **monitoring** of the two pilot EEEP projects **did not receive** as **much attention** as would have been desirable. There is a large volume of project documentation, but the reporting focused on the descriptions of inputs and activities instead of results and outcomes. The involvement of the Academy's steering groups was limited, and the Academy could do more to take advantage of the experience and expertise of the Fellows. Less experienced grant holders would benefit greatly from guidance and support from the Academy's programme management team.

Impacts of the programme

The EEEP delivered clear near-term **impact on teaching methods, curricular and behaviour** within the participating higher education institutions. Participants, in particular secondees and those attending the workshops reported increased awareness of alternative teaching and learning models, adoption of new teaching methods and tools, new materials used for teaching, and in some cases changes implemented in curricula. Curriculum reviews which have a large impact, are resource intensive and require support from the entire system from lecturer, university management and policy-makers.

Secondments not only enriched teaching delivery and content, but they had an **impact on the mentality and outlook of individuals**, enhanced their personal skills and helped establish ongoing working relationships with industrial partners. The EEEP enhanced networking and knowledge-sharing between HEIs nationally and internationally. The programme was not designed to have direct impact on students, instead it used the upskilling of university staff as multiplier to have **indirect impact.**

As a result of the EEEP, individuals are inspired and willing to make changes, but for transformation to happen at an organisational level, further support would be needed. There is a **need build on the momentum created** by the programme, and support the further development of networking activities and extend the benefits from individual participants and departments to faculty and university wide changes.

The EEEP **enhanced collaboration and knowledge exchange between industry and universities**. The secondments were direct examples of this, with university staff learning from industry as well as contributing to solving their problems. 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**. The programme resulted in increased the awareness of the benefits of collaborative activities and contributed to increased liaison between the universities and their partners. For example, 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 contributed to the implementation an 'Innovation and Entrepreneurship Centre'.

Lessons learned

The **economic and social framework conditions** in many partner countries present a key barrier to the sustainability of the programme results as there are often limited resources available locally to support and pick up changes initiated through the programme. Furthermore, many institutions lack **capacity to transparently manage the financial aspects** of international projects. Another hindering factor is due to the lack of **harmonisation and international accreditation** between countries in the region, which makes international staff and student mobility a challenge.

Several factors at the programme level also influenced the implementation of the pilot programme. These include the need for more **increased communication from the Academy** on project objectives and a **mismatch between the project timescale and the programme objectives**. A perceived mismatch between interests of industry and academia presents a challenge and a **clear value proposition** is required to convince companies of the benefit from participation.

A '**project champion'** can be a key success factor, engaging an individual with the respect, time and authority to take the project forward and drive change. Furthermore, securing buy-in and ownership from key national partners can further enhance the relevance and sustainability of the programme. **Teaming up with other initiatives** can help multiply the project effects and share the costs.

Recommendations

Embedding UK links in the programme could provide many benefits and is broadly supported by programme participants and stakeholders. A major challenge is finding a model that ensures mutual benefits and **genuine two-way exchanges** between UK and African institutions. This could be achieved through i) the delivery of lectures or full online courses by UK partners, ii) visiting fellows from the UK engaging in short intensive stays with emphasis on interaction with students or iii) two-way student exchanges where students act as change agents instead of staff.

The evaluation put forward the following **recommendations** for the future scaled up EEEP programme and the Academy's international academy-industry programme portfolio more broadly:

- There is a need to develop a programme logic at the funder level to ensure synergies and complementarities among the programme portfolio
- A well-functioning reporting and monitoring system should be established
- The project length and amount of funding should be reconsidered
- The implementation model of hub and spoke universities was useful for the pilot phase, but should be reconsidered for any follow-up activities
- Managing expectations and contributions of the partners
- Provide guidance to foster the development of successful academia-industry partnerships
- Students should be more involved in the project activities
- Provide opportunities to showcase success stories and increase the awareness of the programme

1 Introduction

This document is the final report of the evaluation of the Royal Academy of Engineering's International Industry-Academia Linkage programme. The evaluation was commissioned by the Royal Academy of Engineering and carried out by Technopolis Ltd between August and December 2016. The evaluation takes the Enriching Engineering Education Programme (EEEP) as the main subject of the evaluation, due to the timing of evidence collection. However, in order to ensure the findings and recommendations are relevant for the Academy's wider portfolio of international industry-academia programmes, the methodology also includes wider stakeholder consultation. The combined evidence is used to provide guidance for the design and implementation of an upscaling of both the individual EEEP and the Academy's broader international industry-academia programmes.

The report first describes the main programme results (section 2) before setting out the main evaluation findings (section 3) and recommendations for future programmes (section 4). The remainder of this section provides an overview of the background and purpose of the evaluation, with a brief description of the methodology used.

1.1 The Royal Academy's Industry-Academia Linkage programmes

Industry-academia linkages form an integral part of programme activities undertaken by the Royal Academy of Engineering. The delivery plan of the Academy states "partnership work lies at the heart of the Academy's approach". There are a number of programmes supporting this approach and this sub-section gives an overview of the UK and international programme portfolio in this regard.

1.1.1 The Academy's UK programmes

The Royal Academy of Engineering is strongly committed to strengthening collaboration between industry and academia[1] to help improve the quality of teaching and employability of engineering graduates. The Academy's Strategic Plan sets out the strategic challenge to "address the engineering skills crisis" for example by bringing "real-world engineering into all stages of the formation of engineers".[2] The Academy manages several programmes aimed at strengthening engineering education and industry linkages in the UK, summarised in Figure 1.

Figure 1 Royal Academy of Engineering schemes to support exchanges between industry and academia

Scheme	Activities	Objectives	Award size
Visiting Professors (VP)	Senior industry practitioners deliver face to face teaching and mentoring at the host university. They may also contribute to the delivery of postgraduate teaching, curriculum development and strategy development.	Enhance student learning, employability and skills of UK engineering graduates.	Up to £10,000 per year over three years
Visiting Teaching Engineers (VTE)[3]	Industry practitioners support the delivery of face to face teaching, mentoring, careers advice and other activities that support the learning experience for full time level 3 engineering technician courses at the host College as well as encouraging level 2 learners onto level 3 technician courses.	Enhance student learning, employability and skills of UK engineering technicians	Up to £2,500 per year for a maximum of 2 years

[1] 'The Dowling Review of Business-University Research Collaborations', available at: http://www.raeng.org.uk/policy/dowling-review

[2] Royal Academy of Engineering: *Strategic Plan 2015-2020,* available at: http://www.raeng.org.uk/publications/strategy-and-finance/strategic-plan-2015-2020

[3] The VTE recently replaced the Visiting Teaching Fellowship scheme (VTF). The VTF focussed on young industrial engineers but was otherwise similar to VP scheme. In contrast, the new VTE scheme is targets Further Education colleges and aims to improve the training of technicians.

Scheme	Activities	Objectives	Award size
Industrial Secondments (IS)	The scheme enables early to mid-career academics to undertake a collaborative research project in an industrial environment for up to six months' full time or part time up to 12 months.	Strengthen relationships and facilitate knowledge transfer between industry and academia. Improve quality and industrial relevance of teaching.	Maximum of £30,000 towards the salary costs

Source: Royal Academy of Engineering Guidance notes[4]

1.1.2 International programmes

Drawing on the lessons from these UK-based programmes – not least the Visiting Professor programme which has been running very successfully for more than 30 years – the Academy has introduced a number of international programmes with similar objectives.

The **Africa-UK Engineering for Development Partnership** was supported by the Anglo-American Group Foundation and the David and Elaine Potter Foundation. It organised a series of workshops in South Africa (2010), Tanzania (2010), Botswana (2011) and Zimbabwe (2011).[5] A study undertaken for the partnership helped identify the specific needs and the challenges holding back the development of engineering capacity in Sub-Saharan countries.[6] These include insufficient government investment, issues of regulation and a 'brain drain' of qualified engineers to other countries and professions. In addition, engineering projects in Sub-Saharan Africa (SSA) are often carried out by foreign contractors, further limiting the prospect of developing local capacity. Engineering education is one of the key factors. Furthermore, there is a relatively low proportion of engineers in the population (one per 10,000) and engineering graduates often lack the relevant skills to meet the needs of industry and the economy. Engineering education suffers from outdated curricula and a lack of opportunities for work related experience for engineering students.

The **Enriching Engineering Education Programme (EEEP)** (pilot phase - 2013-2015) set out to address the problem of skills shortages in SSA. By supporting the formation and strengthening of relationships between academia and industry through staff exchanges and workshops, the programme aimed to ensure that future graduates would have the skills to meet the needs of industry and local challenges. The programme was implemented through two 'hub' and ten 'spoke' universities,[7] engaging academics and industrial partners in the different programme-related activities. The two-way secondments involving the 'hub' universities formulated the backbone of the programme, which was complemented by dissemination workshops with participation from the 'spoke' universities and other stakeholders. The EEEP contains elements from each of the three UK programmes listed above, including academics seconded to industry (similar to the IS programme), visiting fellows from industry seconded to universities (similar to the VP programme) and provisions for improvement of technicians (the VTE programme). The EEEP programme forms the basis for this evaluation, but the research is supplemented by information and consultation on the other models used by the Academy, such as the International Academia Partnership Programme's (as described below) to draw wider conclusions and lessons learnt.

A call for a second phase of the EEEP was launched in 2016. For this call, only organisations that participated in the first phase were eligible. Hub universities from the first phase were also eligible, but they were required to secure match funding from other sources for their project proposals.

[4] Applicant Guidance Notes (2016/17): Visiting Professors; Applicant Guidance Notes – 2015/16 – Visiting Teaching Engineer; Applicant Guidance Notes (2016/17): Industrial Secondments Scheme. Available at: http://www.raeng.org.uk/grants-and-prizes/schemes-for-people-in-industry

[5] "The Africa-UK Engineering for Development Partnership", available at: http://www.engineersagainstpoverty.org/documentdownload.axd?documentresourceid=57

[6] "Engineers for Africa…", op.cit.

[7] Enriching Engineering Education Programme", Royal Academy of Engineering, available at: http://www.raeng.org.uk/publications/other/enriching-engineering-education-programme

Acting as a delivery partner for the Newton Fund, the Academy manages the **International Academia Partnership Programme (IAPP)**.[8] The first projects of the programme were funded starting in the spring of 2016 in Colombia, Thailand, Kazakhstan and India and has since been extended to include South Africa and Indonesia. Similar to the EEEP, the headline objective of the IAPP is 'Enhancing Innovation and Engineering Skills Capacity' to be achieved through knowledge sharing with industry and improvement of curricula. The IAPP however has a broader focus than EEEP, aiming to improve both education and research output. The projects tend to focus on specific engineering topics such as energy efficiency or railroads. In addition, IAPP includes an international component and aims to develop knowledge sharing between the beneficiaries and UK partners through visits and collaboration.[9]

Key activities funded through the IAPP programme enable two-way staff exchanges between universities and industry, and workshops. Reflecting the programme objectives, IAPP projects must include three types of partners: a lead university in the partner country, a UK academic partner, and confirmed industry partners. IAPP also funds overseas academic visits. Applicants are required to provide match funding either in cash or in kind. IAPP projects typically have fewer partners than the EEEP consortia and receive less funding (typically £50k as compared to £140k for each of the two EEEP consortia). The first generation of projects started in 2016 and are still in a relatively early phase of implementation.

Figure 2 Schemes supporting international exchanges between industry and academia

Scheme	Activities	Objectives	Award size
Enriching Engineering Education Programme (EEEP)	(a) Staff secondment schemes between academia and industry (b) Workshops for engineering teaching staff to modernise and improve teaching methods and exchanging experiences.	Address engineering skills capacity in Sub-Saharan Africa, increase the engineering curriculum's relevance, and build links between universities and industry.	Up to £140,000 per hub (phase 2)
Industry-Academia Partnership Programme (IAPP)	Collaboration between university in partner countries with industry and UK counterparts	Improve engineering education and research output.	Up to £50,000 per project

Source: Royal Academy of Engineering Guidance notes[10]

1.2 Objectives of the evaluation

The overall objective of the current evaluation, as set out in the Invitation to Tender document, is to assess and where possible quantify the extent to which the EEEP has been effective and represents value for money for the Academy. A further objective is to provide guidance for the design and implementation of an upscaling of the programme and the Academy's international industry-academia programmes more broadly.

The recommendations should draw lessons and insights from the Academy's UK activities – such as the Visiting Professors and Visiting Teaching Fellows schemes - and the International Academia Partnership Programme (IAPP) implemented in Colombia, Thailand and Kazakhstan as well as the Higher Education Partnership with India.

1.3 Methodology applied

1.3.1 Overview of the methodology applied

Incorporating the Academy's requirements, our methodological approach is based on a mixed-method strategy that combines qualitative and quantitative research techniques, including desk research, interviews, surveys, focus groups (during field visits to the hub universities), analysis of comparator

[8] The titles of the scheme can vary in individual countries but the programmes are referred to collectively as IAPP

[9] This is based on the Academy's LogFrame for Industry Academia Partnerships.

[10] *Applicant Guidance Notes (2016/17): Visiting Professors; Applicant Guidance Notes – 2015/16 – Visiting Teaching Engineer; Applicant Guidance Notes (2016/17): Industrial Secondments Scheme.*
Available at: http://www.raeng.org.uk/grants-and-prizes/schemes-for-people-in-industry

programmes and the preparation of regional fiches mapping the developments in Sub-Saharan Africa (SSA). The methodological annex of the report provides an overview of how the different methods contribute to providing answers to the evaluation questions posed by the Academy.

Desk research

The evaluation team collected and analysed secondary sources, primarily during the inception phase of the evaluation. This included programme documentation, monitoring data and reporting obtained from the Academy, as well as available studies and statistical data.

The document review was particularly important to establish the scope of the engagement (activities) the effectiveness (aims and reporting) and immediate results (outputs) of the programme. It was also used to establish a contact database of individuals and organisations involved in the programme. This, in turn, allowed the team to identify patterns of participation and select relevant respondents for interviews and surveys. (See the separate appendices for a full list of documents reviewed.)

Interview programme

The interview programme was a core element of the study and was used to collect information about the programme and project activities and outcomes, and to discuss motivations, assessment of relevance and to seek suggestions and recommendations for future programmes. Multiple interview guidelines were developed and tailored to the different groups of stakeholders consulted. The evaluation team has conducted more than 60 interviews with core programme participants from universities and industry, national and international stakeholders, as well as Academy staff and board members. Interviewees were contacted by e-mail with a letter of introduction from the Royal Academy of Engineering and requests were followed up by email and telephone as necessary.

Out of the 63 interviews conducted in total, 45 interviews were carried out in person (face-to-face) during the field visits to Harare (Zimbabwe) and Dar es Salaam (Tanzania). The remaining 18 interviews were conducted over the telephone or Skype. Figure 3 lists the number of interviewees from each group. A complete list of interviewees can be found in the separate appendices volume of this report.

Figure 3 Stakeholder groups and number of interviews to be conducted, contact names identified

Stakeholder groups consulted	Number of interviews conducted
Academic secondees from the 'hub' universities	19
Visiting fellows from industry	
RAEng programme management, members of the EEEP and IAPP steering groups	8
HEI management/representatives from the 'hub' universities	6
Employers of industrial secondees and other relevant industry	4
HEI management/representatives from the "spoke' universities	8
National policy makers, representative bodies, associations in the Sub-Saharan countries	12
International experts and donors	6
Total	**63**

Online questionnaire surveys

Surveys have been deployed to seek the views of a broader group of indirect beneficiaries beyond the core programme participants. Their views provide information about the wider 'multiplier effect' of the programme, i.e. the extent to which benefits are spread from the immediate beneficiaries to other academics and the wider groups of stakeholders.

Tailored surveys were developed for two main groups identified during the desk research: workshop participants from hub and spoke Universities, and participants from industry and other stakeholders.

During the inception phase of the study it was decided to engage students through focus group discussions during the field visits, rather than through surveys.

The links to the two online surveys were distributed by e-mail, but respondents also had the option to complete the questionnaires offline and return the completed template by e-mail. The two surveys were open for a three-week long period. Understanding the limitations of the use of online surveys in the target countries, and due to the very low response rate expected, the study team sent out targeted reminders to boost the number of responses. In total, 205 individuals were contacted, out of whom 29 responded giving an overall response rate of 14%. There was only one response received for the industrial survey with regards the Southern hub, while the workshop participant surveys attracted more responses with 13% and 20% response rate in the two hubs. An overview of the responses is presented in Figure 4, and the overview of the survey results is presented in the separate appendices.

Figure 4 Overview of survey respondents

	Number contacted	Number of respondents	Response rate
EEEP academic workshop participants from the Eastern hub	83	11	13%
EEEP academic workshop participants from the Southern hub	87	17	20%
Sub-total	**170**	**28**	**16%**
EEEP industry workshop participants from the Eastern hub	4	0	0%
EEEP industry workshop participants from the Southern hub	31	1	3%
Sub-total	**35**	**1**	**3%**
Total	**205**	**29**	**14%**

Focus groups, workshops

Focus groups and group discussions were used to engage students and staff at the two hub institutions during field visits in October and November 2016. Figure 5 shows the participation by students and staff in focus groups and workshops organised by the evaluation team.

Figure 5 Students and staff engaged in focus groups and workshops

	University of Dar es Salaam	University of Zimbabwe	Total
Students participating in the academic courses at departments involved in the programme	10+	40+	50+
Staff from hub universities seconded to industry	2	12	14

At the University of Dar es Salaam, the two secondees were interviewed separately, and other secondees, who were unavailable to meet face-to-face were contacted for telephone interviews.

Technopolis also ran a workshop at the Academy's annual Visiting Professor conference on 9th November 2016. The workshop was attended by approximately 30 participants, including selected EEEP beneficiaries, IAPP grant holders as well as fellows and staff from the Royal Academy of Engineering. The aim of the workshop was to gain a better understanding of the benefits and possible barriers of engaging in international collaborative activities to support industry – academia partnerships from the participants point of view, and to help validate the preliminary findings of this evaluation. Focusing on the first objective, the audience was asked to discuss three topics relevant to the EEEP, IAPP programmes:

- Key motivations to get involved in academy – industry or academy-academy collaboration?

- Barriers and solutions to successful partnerships
- Routes to achieve significant direct and indirect impact on students

Comparator programme analysis

In addition to considering the Academy's portfolio of international programme, the evaluation team collected data on five other comparator programmes and initiatives. Each had a primary focus which included improving engineering curricula and / or enhancing employability of graduates in the Sub-Saharan region. This analysis of these comparator programmes provides input to the discussion of the further development and scaling-up of the EEEP and the industry – academia linkage programmes more broadly, by highlighting key success and enabling factors, and the transferability of well-functioning aspects and procedures of these schemes.

Data collection on the programmes was carried out in a structured way. Whenever possible, desk research has been complemented by telephone interviews with the responsible programme managers to provide an in-depth view of relevant features of the programmes. The five programmes are:

- African Institute for Mathematical Sciences (AIMS) – Cooperative programme pilot, Senegal
- Development Partnerships in Higher Education (DelPHE)
- KEMRI|Wellcome Trust Research Programme (KWTRP)
- Partnership for Skills in Applied Sciences, Engineering and Technology (PASET)
- Strategic Partnerships for Higher Education Innovation and Reform (SPHEIR)

The full programme profiles can be found in the separate appendices volume of this report.

Regional fiches on Sub-Saharan Africa

The evaluation team has also prepared an overview of developments and framework conditions for engineering education in different parts of Sub-Saharan Africa. For each of four regions in Sub-Saharan Africa – Eastern African, Southern African, Central Africa and Western Africa – the document describes:

- Key demographic and economic framework conditions
- Key human capital development framework conditions
- Key stakeholders
- International schemes and initiatives focusing on the region

The pilot EEEP operated in Eastern and Southern Africa, but could potentially be expanded to institutions in Central and Western Africa. The analysis serves as background information that could be used in any subsequent programme design phase to improve implementation through access to better evidence. The full description can be found in the separate appendices to this report

2 Key results of the Enriching Engineering Education Programme

This section first sets out the programme logic of the EEEP in a model developed for the purposes of this evaluation, before describing the key stakeholders involved and the outputs produced during the programme.

2.1 Programme logic

2.1.1 The problem statement and the programme objectives

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 sets 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.

2.1.2 The model of programme delivery

The two projects in Eastern and Southern Africa were organised according to **a 'hub and spoke' model**. The two hubs, the University of Dar es Salaam (Tanzania) and the University of Zimbabwe, were the main beneficiaries managing the activities funded by the programme. Spoke universities from the regions surrounding the hub universities were invited to participate in training workshops and benefit from the knowledge shared by hub university staff.

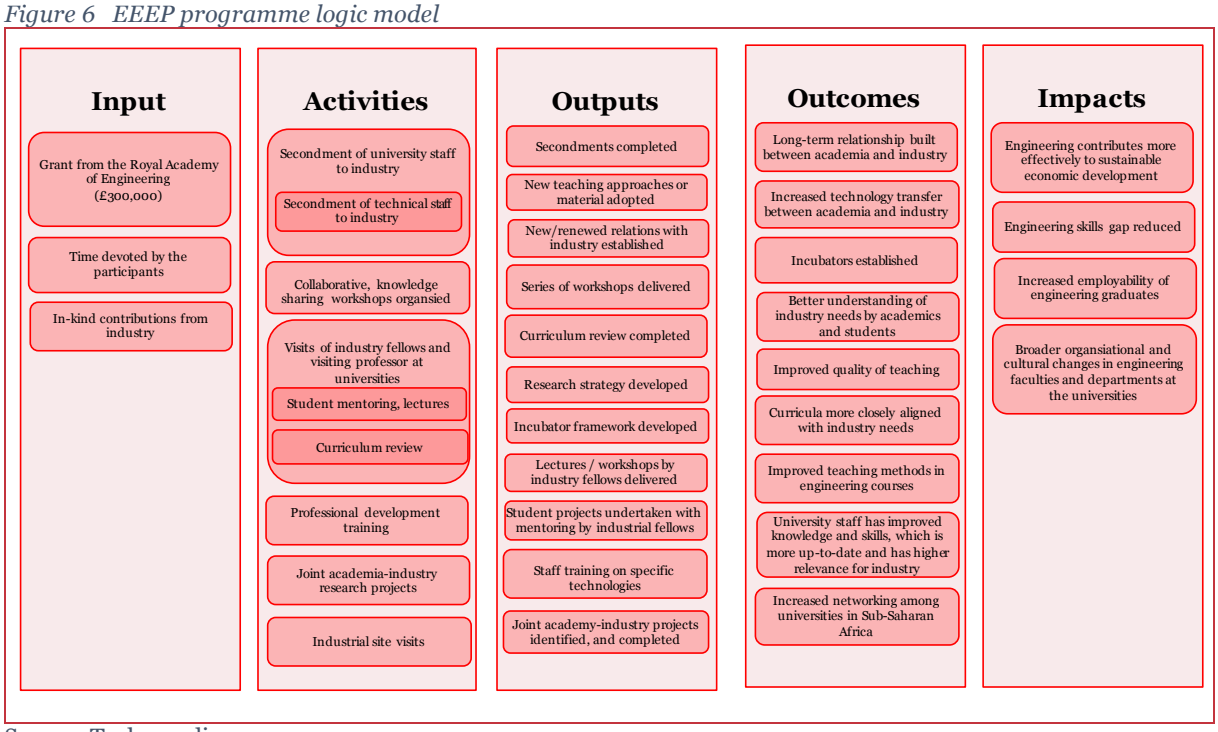
2.1.3 The programme activities

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

- Through **secondments to industry**, university staff was exposed to current engineering practice in industry and gained experience that helped update their teaching approaches and materials to better reflect the current needs of industry. The secondments also contributed to establishing and renewing relationships with the industrial counterparts. The secondees summarised their experiences in reports (Eastern hubs) and participated in knowledge sharing seminars (Southern hub)
- The **Visiting Fellows from industry** were hosted at the hub universities. They provided feedback on, and contributed 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 at the universities
- The programme also included a series of **'professional development workshops'** for engineering teaching staff and a **knowledge sharing workshop** towards the end of the programme. These workshops focused on updating teaching staff knowledge of industry practice, new teaching methods and motivating them to deliver a modernised curriculum. Topics of the workshops included outcome-based curriculum, problem-based learning, innovation support, as well as curriculum review

Figure 6 below shows a programme logic model for EEEP developed by the evaluation team based on evidence collected during the study. No detailed logic model had been explicitly articulated for the EEEP before its implementation, and the two hubs interpreted the 'brief' somewhat differently, although both interpretations were in line with the overall programme objectives.

Figure 6 EEEP programme logic model



Source: Technopolis

2.2 Key stakeholders involved in the implementation of the EEEP

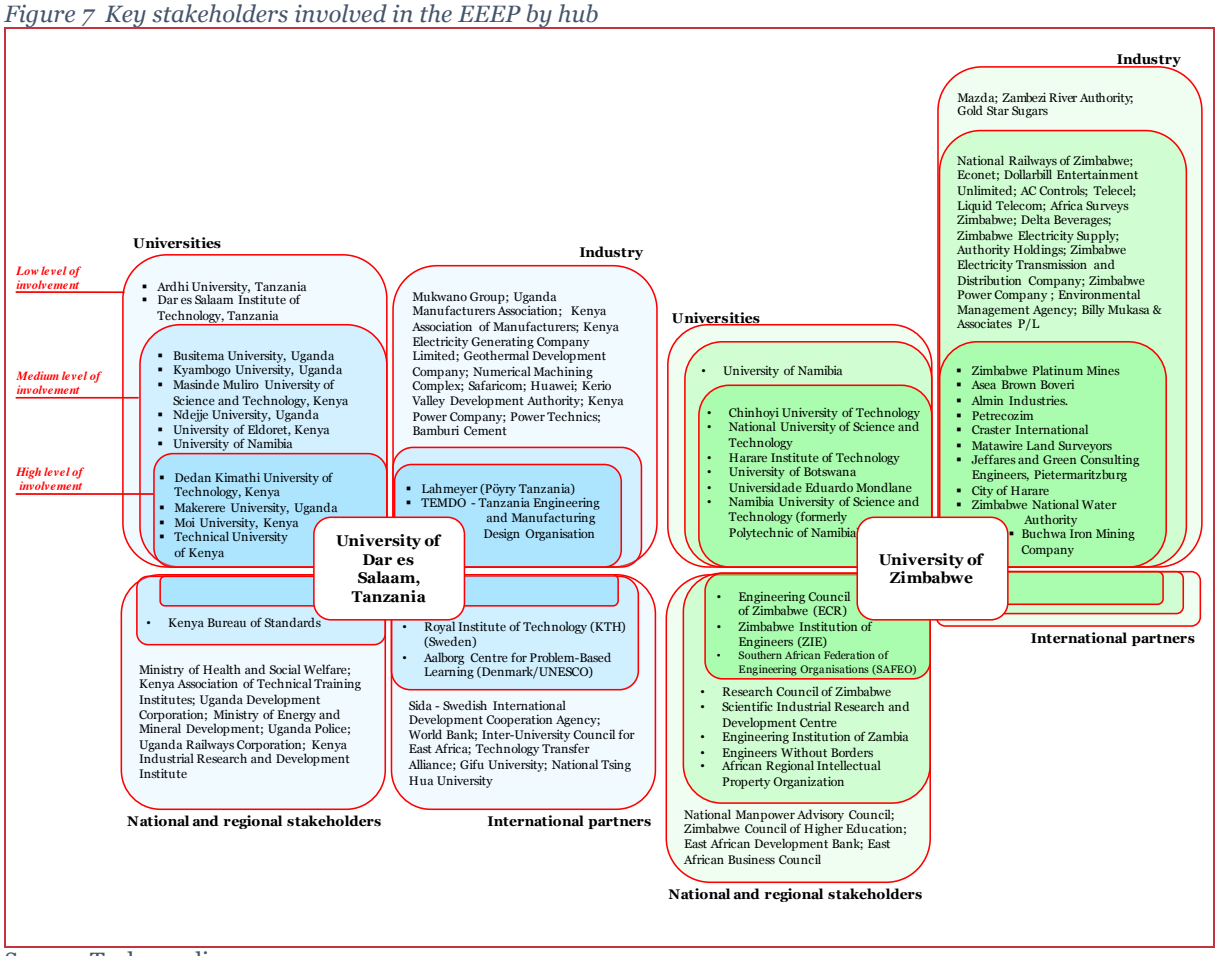
The successful implementation, and the subsequent outcomes of the programme rely to a large extent on the ability to engage key stakeholders in the process. As shown in the programme logic model, this includes universities and industry, but could also encompass other national and regional stakeholders or 'policy makers'. As part of the evaluation, the study team mapped the different stakeholders who were involved in the implementation of the project activities, and assessed their level of engagement with the hub university (in both locations) as follows:

- *High level of involvement*: those organisations that have been critical to the implementation of the project. This includes spoke universities, employers of secondees and other stakeholders that have been directly involved in organising and implementing programme activities
- *Medium level of involvement*: those organisations that have contributed to project activities, for example by attending project events and providing input to workshops
- *Low level of involvement*: Organisations that are reported as relevant to the project without being directly involved in EEEP-sponsored activities. For example, Mazda Motor Cooperation is represented on the University of Zimbabwe's Industry Advisory Board (this board was re-introduced during the programme). As such, they did not contribute to the delivery of the EEEP projects, but play an important role in helping to achieve the long-term goals of the programme

Figure 7 below lists the main stakeholders involved in the two project hubs. It shows that the Eastern hub led by the University of Dar es Salaam had more focus on academic partners and included some international partners from Sweden and Denmark as well. The Southern hub, led by the University of Zimbabwe engaged a larger number of industry partners, including employers of academic secondees. A wider group of companies contributed to the workshops. The Southern hub also had more involvement from local and regional stakeholders. The two models reflect the Academy's intention to enable a needs-based implementation of the pilot projects.

This represents a 'snapshot' of activities during the official programme period (2013-2015). Over time, these relationships may continue to develop and organisations around the periphery could move towards the centre in any future programme.

Figure 7 Key stakeholders involved in the EEEP by hub



Source: Technopolis

2.3 Main results and outputs of the pilot projects

The pilot EEEP programme grants were awarded in July 2012 and the first phase of the programme was implemented between its formal start in August 2013, and its conclusion in the summer of 2015. The three main types of activities were implemented as follows:

- The **secondment of university staff to industry** was generally undertaken during the summer break, typically for 1-2 months, in 2013, 2014 and 2015 (Southern hub only), to avoid disrupting other activities at the university. At the Eastern hub, two members of staff were seconded for two periods each, whereas the Southern hub seconded a total of 17 members of staff to industry for a single period each. They included teaching staff and technicians from the hub university and two teaching staff from spoke universities
- In the Eastern hub, a **Visiting Fellow** was seconded to the university for a total of 40 working days spread over two periods in 2013 and 2014. In the Southern hub, two different Visiting Fellows were engaged for 10 days each in 2014 and 2015 respectively. One from local industry and another from the UK. All Visiting Fellows submitted detailed reports to their host universities describing their experiences and recommendations
- Both hubs organised a series of **workshops** and shared a final conference, that took place at the end of the programme. The aims of the workshops, in general, were to introduce participants to the broader issues related to engineering teaching (there was one exception, taking the form of a workshop that provided training for staff). More specifically, the Eastern hub focussed their three workshops on different teaching and learning concepts: Outcome based curricula, Problem-based Learning (PBL) and best practices in setting up university incubators. The Southern hub organised

a larger number of events, a workshop series, two secondment feedback seminars and a dedicated curriculum review workshop. In addition, a training session was provided for 10 university staff to learn to use CNC machines.

A chronological overview of the main project activities undertaken in the two hubs is provided in the separate appendices.

The programme logic model (Figure 6) shows the main types of outputs expected from the programme. Figure 8 below lists the actual outputs delivered by the two hubs according to these dimensions.

Figure 8 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 secondee	√	– Suggestions for new courses (1 secondee)[11] – Industry feedback on engineering curriculum (2 secondees) – Suggestions for student projects (2 secondees)	– New technical skills learned during secondments and subsequently applied at the university[12]
Links established with industry	√	– Areas for further collaboration identified (2 secondees)	Projects following secondment: – Mushiri implemented two projects at ZIMPLATS[13]
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 delivered 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	√	– Visiting Fellow co-supervised four student projects contributed to BSc courses in two subjects	– Visiting Fellow 1: interactive meetings with 10 students14 – Visiting Fellow 2 (UK): Interacted with students during and after stay
Workshops	**4**	3 workshops and the final conference	7 workshops and conferences (incl. 2 dedicated sessions at international conferences organised by other organisations)
Updating teaching staff knowledge of 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

[11] Industrial Secondment Report for Dr Richard Kimwaga at Poyry Tanzania Limited, October 2013
[12] University of Zimbabwe, Biannual report 2, July 2014, p. 5
[13] University of Zimbabwe, Biannual report, January 2014
[14] Report on the Visit to the University of Zimbabwe, Nesbert M. Mutare, December 2014

Types of Outputs*	Target (**)	Implemented activities	
		Eastern Africa (Tanzania)* **	**Southern Africa (Zimbabwe)*** **
Staff training		[n/a]	– 1 training course for 10 staff in the use of Computer Numeric Controlled (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

The EEEP enabled the two hubs to produce a range of outputs, some of which were not directly anticipated in their initial implementation plans. One significant example includes the **Groundwater project** at the University of Zimbabwe where three technicians seconded to the National Water Authority (ZINWA) implemented a project to improve the water supply to the university. Other important unforeseen outputs are a **new Research Agenda** at the University of Zimbabwe and the reestablishment of an **industry advisory board**. If successfully maintained with active engagement in the University's activities the industrial advisory board could play an important role in enhancing academia-industry relations long-term. In the Eastern hub, the EEEP project activities had an important contribution to make to the establishment of a new **incubator/innovation centre** at the University of Dar es Salaam.

3 Main evaluation findings

This chapter describes the key findings of the evaluation. As highlighted in the methodology section, the study benefits from a large-scale consultation including online questionnaire surveys and an intensive interview programme (carried out both face-to-face and over the telephone) seeking the views of over 150 different individuals. The evidence collected, combined with the desk review, is summarised and presented by the main evaluation question groups in the sections below covering:

- The relevance of the EEEP
- The effectiveness and efficiency of the EEEP
- The impacts of the EEEP

The Academy's broader International Academy-Industry Linkage Programmes set the overarching framework for the evaluation. Through the triangulation of evidence, the wider context is addressed in the formulation of the lessons learnt and recommendations, presented in the subsequent chapter.

3.1 Relevance of the Enriching Engineering Education Programme

To evaluate the relevance of the pilot Programme, the evaluation focused on the assessment of:

- The scope of the engagement
- The motivation and experiences of the EEEP secondees and the main employers associated with the scheme

The Enriching Engineering Education Programme set out to address the problem of an engineering skills shortage in Sub-Saharan Africa by engaging universities in the roles of project leaders i.e. as 'hub' universities and their project partners i.e. 'spoke' universities in a series of activities within two pilot projects. Building on the Academy's Visiting Professor scheme as inspiration, the EEEP pilot provided support to the formation and strengthening of relationships between academia and industry through two-way staff exchanges and a series of workshops.

The pilot programme had **multiple objectives**: to help build engineering capacity as well as to improve engineering education to ensure that future graduates would have the skills to meet the needs of industry and local challenges. These programme objectives were identified based on a consultation series carried out by the Academy in Sub-Saharan Africa in 2010-11. Although there have been changes and advancements in the programme countries during the past five years, the interviews carried out by this study team reaffirmed that **the rationale of the programme is still highly valid** and represents an area that needs further support.

Stakeholders consulted as part of this evaluation all have very clear understanding of the strengths as well as the shortcomings of current procedures and systems. Such recognition is combined with interest and willingness to get involved in programmes and initiatives that are aimed at improving the current state of play. The different stakeholders who were consulted as part of the evaluation highlighted the following issues:

- **Industrial partners** engaged in the programme expressed a strong desire to attain better trained and qualified graduates (referring both to their hard and soft skills), to increase the industrial-relevance of academic research and to improve knowledge exchange with the higher education institutions

- **Teaching staff and researchers** also reflected on the need for, and importance of, upskilling and gaining relevant practical knowledge to better understand industrial practices. They are eager to learn about new teaching and research methods, international good practice and the use of the state-of-the-art equipment. They repeatedly emphasised that educating students is their primary task and main 'result' of their work. It is vital to ensure that students are highly-

trained, competent and equipped with the knowledge and skills needed, and considered valuable, on the labour market

- **Intermediaries and other professional bodies** (including engineering associations) highlighted the need to increase the quality of engineering education in line with international standards, which would ultimately also improve opportunities for international mobility and employability

- **Engineering students** demanded new curriculum content as well as improved delivery, access to problem and project-based learning, increased focus on developing their soft skills and the entrepreneurial mind-set, better access to modern facilities and infrastructure as well as opportunities to gain more practical experience through direct contact with employers, industrial partner

Practical learning as well as attachments (i.e. placements) are highly valued by the students. Attachments for engineering studies are applied to a different extent and length, but are available in every higher education institution consulted as part of this study. The shortest attachments are eight-weeks, while the longest ones fill almost a full academic year and are 30 weeks long.

Finding suitable student attachments however depends on the availability of companies who can host them. In some countries, for example in Tanzania, engineering firms are expected by the national regulations to train engineers

Figure 9 What students are asking for regarding their engineering studies (n=50+)

Source: Technopolis discussion with student at the two hub universities. The image was created by using an online word cloud generator[15]

The bulk of the consultation was carried out in the two hub countries. The discussions focused on exploring problems and issues as well as motives for participation, activities undertaken and key successes. Survey responses from workshops participants and interviews with the spoke university representatives confirmed that many of the problems identified in the fields of engineering education, engineering capacity building as well as more broadly regarding developing and nurturing industry-academia relations, are common for most of the countries in Sub-Saharan Africa.

Although there is a **shared recognition of the need for change**; the economic situation, financial pressures alongside everyday tasks and priorities often derail the development of solutions. It is a daunting task to address all the above sets of requirements, and higher education institutions cannot do so in isolation. There is a need for joint effort and collaboration to address these challenges. The inherent differences between the worlds of academia and industry – for example working with different time-scales, lack of understanding of each other's needs, structures, practices or even just the language used – can create difficulties that often seem unsurmountable. The EEEP **pilot projects gave an important impetus to starting a change process** by bringing together academia and industry together with other national and regional stakeholders in collaborative activities.

Representatives from the participating higher education institutions reflected on their **motivation** for becoming engaged in the pilot EEEP projects within the consultation process. There are distinct differences between the **hub and spoke universities**:

- The hubs during this pilot phase of EEEP had leading roles in the design and implementation of the project activities, and had clear ideas about the expected benefits of participation. Secondees from the hub universities gave accounts of their individual motivations, reflecting on the need **to deliver industry relevant education and research** as well as the intention **to**

[15] https://www.jasondavies.com/wordcloud/

give back to industry. The secondments presented an opportunity for academics that was largely unprecedented. Having the opportunity itself generated enthusiasm and interest among the academic secondees, which was however combined with some level of discomfort due to not knowing what to expect

- At the same time, spoke universities were offered the opportunity to 'learn through experience exchange' i.e. having more of an observational role. In line with this division of labour, spoke university representatives had realistic expectations and mentioned the opportunity to **gain new ideas, develop staff capacity through mutual learning**, **establish new relations** and **learn about topics** that are highly important but rather challenging (e.g. staff secondments, new pedagogical development, academia-industry collaboration) as key motivations for participation

The table below provides a summary of the survey responses of the workshops participants from both hub and spoke universities. Out of the 28 respondents, ten respondents participated in only one workshop, while all other respondents participated in at least two, more often three workshops.

Figure 10 Motivations of the workshop participants for participation

Main motivations	All respondents	Respondents from the Eastern hub	Respondents from the Southern hub
Participated in the WS due to having administrator/organiser role	18%	18%	18%
To learn about new practices and teaching methods, and ultimately improve engineering education	43%	64%	29%
To improve one's understanding with regards academia-industry relations	18%	9%	24%
Other reasons	21%	9%	29%
Number of respondents	**28**	**11**	**17**

Note: highest values are shaded in grey

Source: Technopolis, hub and spoke universities - workshop participant survey, 2016

It is a common approach for industry to engage in research and consultancy-related activities with academic partners. However, companies usually have much less involvement in education-related activities. This is partially due to the fact that teaching requires specific qualifications, knowledge and skill sets. Furthermore, the immediate and direct benefits of getting involved in education-related activities are less prevalent. Hub university representatives gave accounts of some initial difficulties in engaging industrial partners in the secondments. Selling the 'win-win' idea to industrial partners was a challenge, especially without previous successful examples available to showcase. Therefore, building on personal contacts and using already established relations (such as engaging alumni) were all important elements in the successful implementation of the secondments.

Those **industrial partners**, who decided to get involved in secondments as host and/or sender organisations provided the following **motives** for participation in the EEEP pilot:[16]

- There is a clear recognition that some of the **teaching staff needs upskilling**, and industry has the modes and means to contribute to addressing this problem
- Companies are driven by the need **to discuss** with academics what their **expectations** are in terms of **education, training and research**
- There is a **long-term pay-off** which is understood by the industrial partners: it is better to give graduates good university training rather than spending a long time on training/induction of lower skilled graduates when they are already in employment

[16] There were only two industrial fellows in the pilot programme and a visiting professor from the UK

- The **acknowledgment of industrial responsibility** and participants' **individual drive** to provide input to engineering education. These were echoed in the comments from the industrial fellows, both of whom already had strong links with their host university (carrying out PhD studies, occupying part-time teaching positions) when they agreed to undertake the secondment

The **UK visiting professor** who participated in the pilot programme, gave an account of their **personal motivation to volunteer** for activities that have a long-lasting result. The EEEP pilot was regarded as a good option, because the programme set out to address real problems that needed solutions.

Overall, the motivation, enthusiasm and the aspiration of the individuals engaged in the programme to **make engineering education better and more relevant** were the key drivers of the implementation of the pilot activities. The programme objectives are regarded highly relevant by all stakeholders, and there is strong willingness to foster change. This is a very valuable insight for the design of the scale-up of the programme and the objectives provide a solid foundation for any follow-up activities.

Relevance of the programme

The EEEP was designed to address is the engineering 'skills gap', which is an existing problem for engineering graduates. The programme objectives are regarded highly relevant by all stakeholders, and there is strong willingness to foster change. Different stakeholders have a very clear understanding of the strengths as well as the shortcomings of the current system. Among the main needs identified by the stakeholders were better trained graduates, increased relevance to industry, upskilling of university staff, access to equipment and improvement of education in line with international standards.

Motivations and expected outcomes of the different stakeholders reflect their level of involvement in the project. Hub universities got involved in the programme to improve the delivery of industry relevant education and research, while spoke universities want to gain new ideas, develop staff capacity through mutual learning, establish new relations and learn about important topics. There are only a few companies engaging directly in education-related activities, as the benefits tend to be longer term rather than immediate / short term. It therefore remains a challenge to 'sell' the win-win idea to industrial partners.

3.2 Efficiency and effectiveness of the Enriching Engineering Education Programme

The evaluation questions regarding the efficiency and effectiveness of the pilot EEEP explored:

- Whether the financial level and duration of grant made by the Academy was appropriate
- The extent to which EEEP secondments and workshops had clear goals, objectives and expectations at the outset and throughout their posting
- The effectiveness of the reporting and monitoring mechanisms applied and the identification of metrics and approaches to assessment that could be used in future

To assess the efficiency and effectiveness of the programme first the overall implementation model is discussed. This focuses on the engagement of the different stakeholders in the various activities, the observations on the implementation of the pilot projects and the issue of value for money for the Academy. The chapter then describes the findings in relation to the monitoring of the programme.

The **implementation of the two pilot projects** stretched over a two-year period, and as was already described, involved a hub and spoke model. Therefore, by design it has a **strong focus on the engagement of hub universities** with a somewhat **peripheral involvement from the spokes**. The central activities of the programme i.e. the two-way secondments as well as the workshops were foreseen to be organised by the hub universities. The hub universities were also in charge of the administrative and financial management of the project implementation. From among the planned activities, the various dissemination and knowledge sharing workshops were foreseen as the main tools and platform for engaging with the spoke universities. Overall this gave a more passive role for the spoke universities, mainly as an observer.

The pilot nature of the programme, combined with the light-touch approach towards monitoring by the Academy, resulted in two different implementation models by the hub universities. The universities tailored the project implementation in a way that best suited their economic situation, development goals and overall needs. As already stated in the previous chapter, both hub universities delivered on the requirements set by the Academy, and even exceeded the expectations in some respects.

Both hub universities (South and East) engaged the spoke universities to a higher degree than intended in the original programme design. However there were variations in how much, and in what type of activity. The Southern hub engaged the spokes more clearly in secondments and governance, the Eastern hub focused more on workshop involvement and dissemination.

The Southern hub gained significant industrial commitment during its implementation and therefore was able to involve two of the spoke universities in academic secondments. In addition, they established a Steering Committee for the project that included representatives from the spoke universities. However there is little evidence of significant engagement of the Southern spoke universities in the workshops, which concentrated on involving stakeholders from Zimbabwe. Therefore this approach can be said to have involved the spokes in a limited (select) but deeper way.

The Eastern hub put a greater emphasis on opening up the workshops to the spoke universities. The three workshops took place in three different countries, thereby facilitating access to all and resulting in increased participation by the spoke university staff. The method of implementation chosen by the Eastern hub was more suited for awareness raising and delivering on different topics of common interest e.g. problem-based learning and outcome based curriculum, entrepreneurships and innovation support. This provided a platform for wider discussion and experience exchange among the hub and spoke universities.

The differences in the project implementation between the two hubs are also reflected by the types of stakeholders who participated in the various workshops. The table below provides a summary of the workshop participants based on information gained from available project documentation.

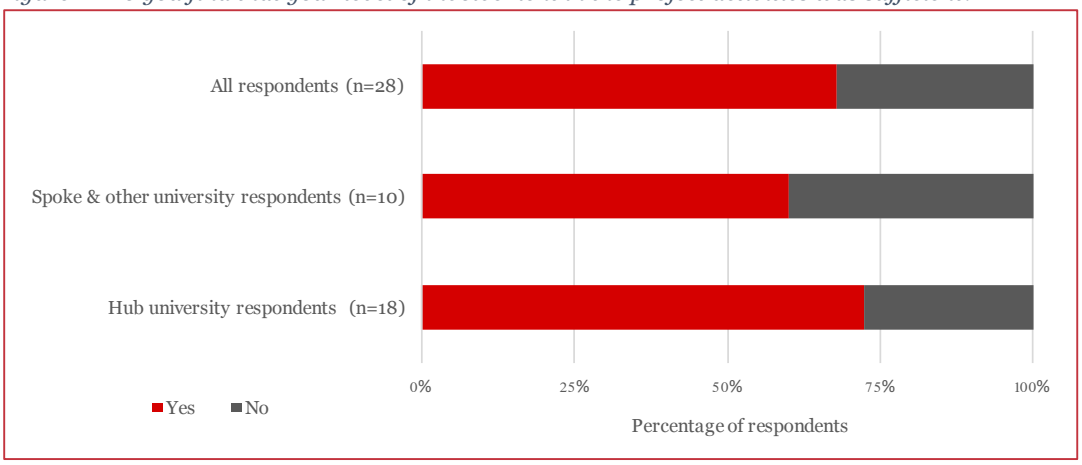
Figure 11 Overview of the workshop participants organised as part of the pilot EEEP

	Southern hub	**Eastern hub**
Number of workshops	5 workshops, two feedback seminars and the end of programme conference	3 workshops and the end of programme conference
Number of individuals participating*	Approx. 160 – detailed information is available on five events	Approx. 130
Average number of participants*	About 60	About 43
Number of HEI representatives	**Zimbabwe**: - University of Zimbabwe – 92 individuals - Chinhoyi University of Technology – 14 - NUST – 5 individuals - Harare Institute of Technology – 2 individuals **Other HEIs with 1 or 2 individuals each:** **Botswana**: University of Botswana **Mozambique**: Universidade Eduardo Mondlane **Namibia**: Polytechnic of Namibia and University of Namibia	**Tanzania**: - University of Dar es Salaam – 39 individuals **Kenya**: - Moi University – 22 individuals - four other HEIs with 1 or 2 individuals **Uganda**: - Makerere University – 27 individuals - two other HEIs with 1 individual each **Namibia**: University of Namibia – 1 individual **Zimbabwe**: University of Zimbabwe - 3
External partners	Over 20 different stakeholders from Zimbabwe and a UK visiting professor	International higher education experts from, Denmark, the UK and Sweden Two professional bodies from Kenya and one from Tanzania

Note: * the information presented is based on the monitoring and reporting documentation received from RAEng

The chart below provides an overview of the extent to which survey respondents from the hub and spoke universities considered their level of involvement in project activities as sufficient. This is compared to the average of all respondents to the question. From the 28 survey respondents, 19 found their engagement sufficient, while the others called for more involvement. Respondents from the spoke universities who answered 'not sufficient' to the question, participated in only one workshop. Their counterparts from the hub universities had multiple workshop participations, and in their comments asked for more intense academia-industry relationship building.

Figure 12 Do you find that your level of involvement in the project activities was sufficient?



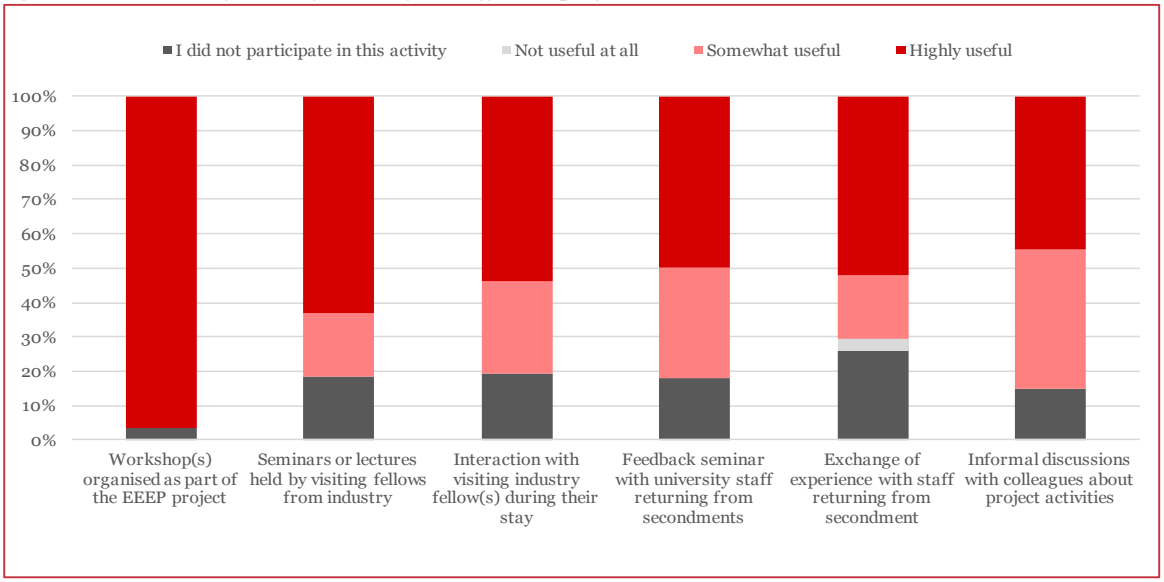
Source: Technopolis, EEEP workshop participants survey

The interviews conducted with the representatives of the **spoke universities** reinforced the results of the online survey. Most of them highlighted, that **more active involvement would have been desirable** and beneficial for their institutions, and if opportunities arise, they would be glad to be more engaged in future activities.

Survey respondents were also asked to indicate the **usefulness of the different EEEP activities**. During the interpretation of these charts, it should be however noted, that the survey specifically targeted workshops participants, therefore there is an inherent positive bias in the responses.

The chart below clearly displays that **workshops are regarded as highly useful** by most respondents. International experts participating in the different workshops observed how important they are, and appreciated by participants. The workshops provided **unique opportunities** for many of them **to meet**, and the opportunity to establish good contacts. There is however one common **question** raised by these experts, which is **about the sustainability of these relations** in the absence of further funding.

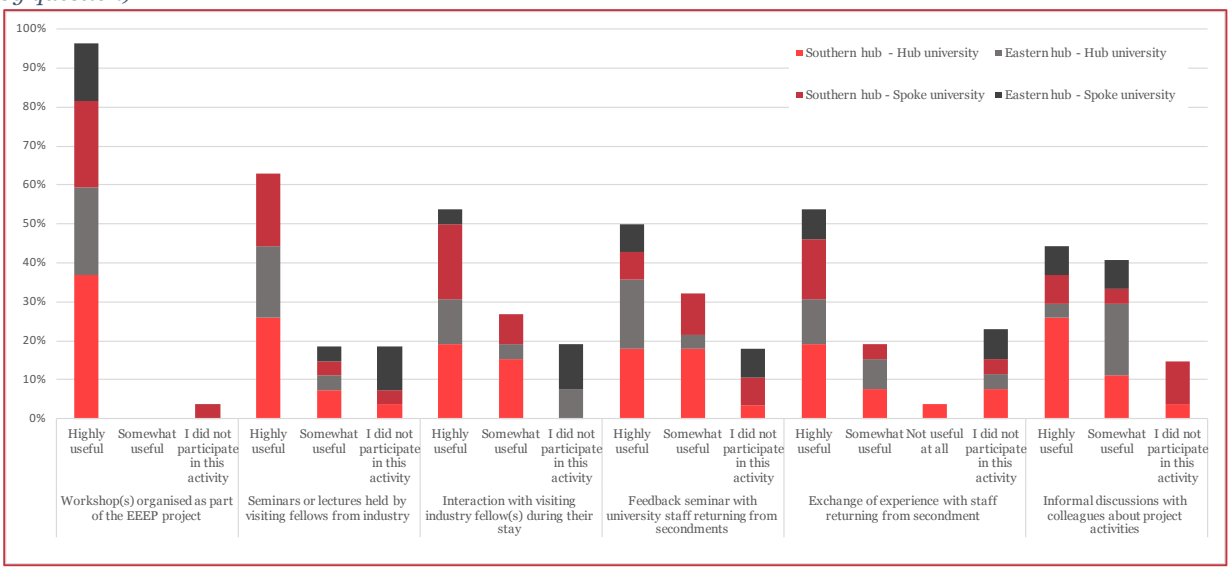
Figure 13 Overview of the usefulness of the different project activities (n varies between 27 and 28)



Source: Technopolis, EEEP workshop participants survey

The **lectures held by visiting fellows** from industry were regarded as very **useful** by over 60% of the respondents (although no spoke university from the Eastern hub responded to this question). Looking more closely at the different types of organisations across the two hubs, the same overall pattern can be observed as with the overall survey population. Making a distinction between the hub and spoke university responses however confirms that spoke university staff had less opportunity to engage with industrial visiting fellows. Therefore, many of them answered 'no participation' in the fellows-related questions due to programme design rather than a lack of interest or ineffective implementation.

Figure 14 Usefulness of the different EEEP activities by hub and type of organisation (n varies between 26 and 28 by question)



Source: Technopolis, EEEP workshop participants survey

Interviews and group discussions with the **secondees** revealed similar **positive views with regard to secondments**. Interviewed secondees were highly motivated, inspired and highlighted a variety of experiences obtained during the secondments. At the same time, academic secondees, especially the technicians and the spoke university secondees, gave account of **low levels of involvement in other EEEP activities**, such as workshops or interaction with the visiting fellows.

Although there was no direct involvement of the spoke universities in some of the activities per design, their views point to a few areas for improvement regarding other EEEP activities. **Exchange of experience with staff returning from secondment** (23% of the respondents indicated somewhat useful or not useful at all), **feedback seminars** (33% - somewhat useful) and informal discussions with colleagues (41% - somewhat useful) were regarded **less useful** by the respondents. This lack of wider dissemination of the feedback and experiences of the secondees suggests some missed opportunities. Enhanced communication within the universities to share their experiences and discuss the problems more widely could have helped generating spill-overs more broadly.

The **project implementation focused specifically on engineering faculties**, but even within the faculties there was **some concentration on specific departments**. This is a missed opportunity although many of the topics discussed could have benefitted from inter-faculty collaboration. For example, engaging other faculties in interdisciplinary project work for the students is a proven method to develop students' soft skills, and an important element for their increased employability.

The other set of core activities of the pilot projects were centred around the **two-way secondments**. Interviews and group discussions with the secondees, their industrial hosts as well as the visiting professor, gave insight into the different aspects of the implementation of the secondments. Regardless of the differences in the number of secondments implemented by the two hubs, there are many similarities in the approaches used. These include the following:

- The **secondments were set up and centrally organised in the hub universities**: the project managers identified the industrial partners, defined the objectives of the secondment, set up and monitored them, as well as coordinated any further reporting-related activities and workshop participation. For the two spoke university secondees in the Southern hub, their respective university arranged the secondments, **the individuals** themselves **had limited influence over the decisions**

- The length of the secondment was usually a month (around 20 days), and carried out two times during two consecutive years. Opinions about the **length of an ideal secondment vary**. There is no one solution fit all. Major influencing factors include: work and family-related responsibilities; the sector and subject of the secondment (e.g. construction project that lasts for years or a highly targeted mechanical engineering project, that can be addressed during a months); the length of the necessary induction period at the industrial host

- For academic secondees the **time spent away** was scheduled to take place during the students' vacation time, to ensure minimal disruption in the academic year. For industrial fellows the timing differed, and concentrated on time periods, when students were also present on campus to facilitate the industrial fellows' interaction with the students

- There was **no formal selection process or common criteria** established for how to choose the secondees. On the academic side, raising interest to participate in the secondment was sufficient (depending on the places allowed). For the industrial partners, if more candidates were available, the individuals teaching skills were favourably considered during the selection

- The **novelty** of the idea of two-ways secondments **generated some resistance** among the industrial partners to engaging in the project activities. This presented challenges for the organisation of the secondments and also mirrored the initial anxiety of some of the academic secondees. There was an absence of cases of successful implementation of an academy-industry secondment at that time. This was compounded by the difficulty in therefore providing examples of immediate benefits to industry if they seconded an industrial fellow to a university for a month. These barriers were **overcome by** the persistence of the project managers and by **using already established relationships**, approaching **alumni** networks and partner companies of the universities to find those willing not only to act as host organisations, but as senders of industrial fellows

- With a few exceptions, there was **no transparent communication about the method of matchmaking** between academics and potential industrial partners i.e. understanding the needs and required expertise of the company to find the most suitable academic (with interest) for the secondment. The host organisations gave account of no prior knowledge of the skills and expertise of the secondees arriving. The exact tasks and the potential contribution of the secondees were most often agreed upon during the first day of the secondment
- The secondees and industrial fellows prepared **detailed reports** about their experiences, and they were also provided the opportunity to share their experiences during different workshops organised as part of the projects

The secondments were highly appreciated by all the academic secondees interviewed and **delivered many benefits, predominantly at the level of the individual**. The anecdotes of the academic secondees regarding the successful implementation of the secondees and the mutual benefits, were reiterated by the industrial partners. With hindsight, the secondees pointed out a few **areas for improvement.** These include:

- The **project timetable imposed some constraints** on the selection of secondees – at the beginning of the project, the selection of academic secondees had to be done relatively quickly. For secondments to work the best, there is a need to establish win-win situations, based on matching the right people and skills with the needs and expectations of the partners
- There is a **clear need to provide guidance** for secondees as well as for the sender and host organisations to ensure that the secondments are undertaken in the most effective manner. In the pilot projects, the secondments were rather loosely framed. More strategic thinking about the approach taken, including setting joint objectives could help maximise the impacts delivered through these secondments
- There was **limited interaction between the students** and in some cases between faculty staff **and the Visiting Fellows** at the host universities. This is partially due to the relatively short time spent by them at the University in the Southern hub for example. The Visiting Fellows gave speeches, which was regarded helpful by the academics who attended, and talked to students (motivational speech delivered), but it is essential to capitalise on such visits to the maximum possible extent, and preferably build sustainable relations

To put these activities into context, and help establish the value delivered by the different activities, the study team compiled a few headline figures from the available documentation about the costs per activity. The figures below are approximate, although based on incurred costs, and were calculated to show the range of costs. They are not precise by any means.

Figure 15 Estimated incurred cost per activity

Type of activity	Estimated costs	Comments
Academic secondees	$1,000-1,500/month per person for local secondments Up to $5,000/month per person for secondments at other locations than the workplace	The price of accommodation and travel need to be calculated for secondments away from home These figures assume, there is no replacement costs involved at the universities, due to the academic being away during student holiday time
Industrial secondees	$5,000/month per person	Depends on the level of industrial contribution, cost related to the replacement of staff on secondment should be covered
Visiting fellow	No data available	
Workshop organisation	Range of average cost per person: $250/person per workshop – local participants $300-500/person per workshop – 1-2 days long workshop, involving limited number of international participants	The workshops organised as part of the pilot projects vary from one-day workshops engaging local participants to the contribution of large international conferences. On average the EEEP workshops had between 40-60 participants each

Type of activity	Estimated costs	Comments
	$600-700/person per workshop – 2 days long workshop, with high level of international audience	
Training activities for staff	$200-300 per person	Specific, highly targeted training activities, that were used during the pilot project

Source: Technopolis, based on reporting information received on the EEEP projects

In approximate terms a month secondment away from home equals with the costs of organising a 1 day long workshop for a local audience of 20 people or a 1-2 day long workshop for international audience of 8-10 people. As **these activities serve different purposes, their use should be established with due consideration for the intended results.** In case of the workshops, the target audience and required number of participants should be carefully thought out and follow-up activities, including further dissemination, ensured.

Reaching the high-level objectives set by the programme requires a **cultural change and shift in mentality**. Such change **happens over a long time**, and programmes of similar types – focusing on transformation of education - usually embrace longer-time frames. International as well as UK experts consulted as part of the evaluation share the views that a time-frame of a minimum of three and up to five years is usually needed to ensure that changes can occur. Looking at the timeframe of project implementation in the Southern hub, this suggestion seems very realistic. As part of the project, that started in August 2013, using the feedback collected from the secondments, input from the industrial partners, and the discussions at the various workshops, the Faculty of Engineering carried out a curriculum review in July 2015. The reviewed curriculum was then submitted for accreditation to the relevant national authority, and the university hopes to introduce the new curriculum in February 2017.

An **extended time frame** would allow for greater flexibility to align project implementation to the changing needs and provide a suitable timeframe to carry out **much needed follow-up actions**. At the same time, it represents a higher risk of off-the-mark project implementation, if it is not **designed and monitored well.**

Monitoring of the pilot EEEP projects did not receive as much attention as would have been desirable. Frequent changes in personnel at the Academy – there were three or four people involved in the setting up and running of the two-year long pilot projects – hindered efficient monitoring and caused some disruption in having a comprehensive overview of the project implementation and activities.

Our study team reviewed all reporting and monitoring documentation received from the Academy, and compiled a full list of outputs, reviewed the time sequence of the activities, workshops undertaken as well as mapped the different stakeholders who contributed to the implementation of the projects. This involved consulting and mining data from the 70+ documents produced during the two years of the programme. The pure volume of the documents is rather overwhelming, there were slight discrepancies is reported figures and the information was often anecdotal. This made it harder to establish a fact-based overview of the project implementation.

There were agreements between the Academy and the hub universities, which outline **indicators and metrics** as well as the outline of a monitoring framework. These however differ between the two hubs. In practice, reporting focused on some activities, for example the secondments in the Eastern hub, but not on others (e.g. workshops). Indicators and metrics were not used – as far as the study team could establish – as part of the reporting. The Southern hub commissioned an external evaluation at the end of the project. This review highlights important lessons in itself and prompts the need for a more structured monitoring and reporting system, that can be easily overseen even by new personnel within the Academy, especially if the programme portfolio is foreseen to grow in the future.

Similar observations can be made regarding the Academy's engagement of the **steering groups** established **for** both the **IAPP and EEEP projects**. The study team interviewed members of these groups to gain a broader understanding of the set up and management of the programmes. Interviewees

gave account of low level involvement, relatively infrequent meetings, and somewhat outdated knowledge of the progress of the different programmes. Having secured the willingness of high profile individuals, the Fellows of the Academy, to contribute to the overseeing the programmes, it is highly recommended to further **exploit their experience and expertise** for the benefit of the programmes.

In addition to effective monitoring by the Academy, **good project management on the beneficiaries' side** is another cornerstone of successful project implementation. Those grant holders who are novice or less experienced in managing international multi-stakeholder projects, can benefit from **advice and guidance to fine-tune the activities** and maximise the benefits and impacts delivered through the efficient use of the available resources. The day zero of the Birmingham Visiting Professor Conference[17] was dedicated to the interaction between international participants, who voiced many questions and sought input for methods on how best to implement their projects (both IAPP and EEEP). It is clear, that the Academy has an important role to play not only as the funder of these project activities, but through **providing good practice examples**, and disseminating lessons learnt and fostering **networking and mutual learning**, activities that all contribute to increased effectiveness of capacity building and effective and efficient project implementation.

Efficiency and effectiveness

The project structure allowed for some flexibility to implement the projects tailored to local needs. The Southern hub had a strong focus on in-depths involvement of a core group of stakeholders, including industrial partners and stakeholders, while the Eastern hub created a platform for wider discussion and networking for a larger international stakeholder group but with less intense involvement. Overall, the hub and spoke model was fit-for-purpose for a pilot phase. Combined with the lessons learnt from the two different approaches the experiences from the pilot phase provide useful lessons for the scale-up of the programme.

Stakeholders gave an overall positive account of their participation, in particular workshop participation and secondments were regarded very useful. The secondments were very positively assessed by everyone, however their implementation leaves some room for improvement to maximise mutual benefits. The project activities serve different purposes and represent different costs and values, therefore their use should be established in line with the intended results.

A month secondment away from home equals with the costs of organising a 1 day long workshop for a local audience of 20 people or a 1-2 day long workshop for international audience of 8-10 people.

Limited interaction among the different project activities represent a missed opportunity for further enhancing the results of the projects.

The implementation of the projects focused on engineering faculties, but even within the faculties there was some departments more heavily involved than others. Reaching the high-level objectives set by the programme requires a cultural change and shift in mentality. This does not only require a longer time frame for implementation, but a less isolated, more open inter-faculty collaboration within the universities.

Monitoring of the pilot EEEP projects did not receive as much attention as would have been desirable. Reporting covered different aspects of the project implementation by the two hubs and indicators and metrics were not used optimally. The Academy has an important role to play in achieving increased efficiency and effectiveness of programme delivery. In addition to tailoring the monitoring and reporting system, this also includes provision of advice and guidance to less experienced beneficiaries regarding project management.

[17] Further information on the annual conference: http://www.raeng.org.uk/events/list-of-events/2016/november/annual-visiting-professors-conference-2016

3.3 Impacts of the Enriching Engineering Education Programme

Main evaluation questions regarding the impacts of the pilot EEEP

- The extent to which EEEP secondments and workshops have influenced teaching methods and behaviours within and across the departments of their host institution
- The extent to which EEEP secondments and workshops have either enriched or influenced the curriculum of engineering courses they have been associated with
- The impact of EEEP secondments and workshops on students and Higher Education Institute staff
- The extent to which EEEP secondees have contributed to technology transfer into industry
- 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

The pilot projects finished more than a year ago, therefore some of the short-term, immediate impacts of the projects can already be observed. This section describes the impacts of the programme along two overarching categories:

- Impact on teaching methods, curricula and behaviours within universities i.e. impact on the academics, secondees, the students and the HEI more broadly
- Technology transfer into industry, and more broadly collaboration with industrial partners

Impact on teaching methods, curricula and behaviour within universities

As highlighted in the previous chapter, workshops and secondments were regarded as very useful by academics as well as external stakeholders. The workshops provided a platform for much needed exchange of experience, knowledge sharing and networking. The workshops which focused on teaching methodology and curriculum review were highlighted as the most useful. According to the unanimous views of the survey respondents, the model with workshops was an effective way of enriching engineering education. The pilots have increased awareness of alternative teaching and learning methods, both with regard to content and delivery. The discussions contributed to enhanced networking and in some cases – especially for the hub universities - manifested in **implementation of changes in teaching methods and curriculum**.

In terms of the impacts, the survey responses and the interviews show that both the workshops and the secondments (especially) had an **impact on the mentality and outlook of individuals**. Workshop participants gave account of **new methods learnt,** and **broadened horizons** regarding **approaches available for teaching** with **increased industrial relevance** and more generally gained **inspiration to change**. Lecturers started to consider taking students on industrial visits, showing an understanding of how the practical application of course content can improve theoretical understanding.

The survey results reinforce these findings regarding the impact of the EEEP activities on teaching and the curriculum. Survey results show that 83% of the respondents agreed or strongly agreed with the statement, they have **changed the teaching methods** they use in their classes. An even higher proportion 87% of the survey respondents agreed or strongly agreed with the statement, that they have learnt **new tools or methods** for their work. Changing the content or curriculum of the classes that they teach is less prevalent. Only 48% of the respondents agreed with this statement, most of them representing hub universities. Those, who gave account of not much change in their teaching methods or curricula (neutral or disagree) in spite of their participation in the EEEP workshops, pointed out a **lack of policy support and financial difficulties as main barriers.**

Figure 16 Impact on teaching methods and curriculum

Statement	Level of agreement	Type of university		Total	Number of responses
		Hub	Spoke & Other		
Impact on the individuals					
I have changed the teaching methods that I use in my classes	Strongly agree & agree	48%	35%	83%	23 (100%)
	Neutral	13%	4%	17%	
I have learnt new tools or methods that I can use at work	Strongly agree & agree	50%	37%	87%	23 (100%)
	Neutral	13%		13%	
I have changed the content/curriculum of the classes that I teach	Strongly agree & agree	35%	13%	48%	24 (100%)
	Neutral	22%	17%	39%	
	Disagree	4%	9%	13%	
Impact on the higher education institution					
The faculty or department has changed curricula for engineering courses	Strongly agree & agree	29%	13%	42%	24 (100%)
	Neutral	29%	21%	50%	
	Disagree & strongly disagree	4%	4%	8%	
The faculty or department has given new guidelines or instructions regarding teaching methods	Strongly agree & agree	50%	33%	83%	24 (100%)
	Neutral	13%		13%	
	Disagree		4%	4%	

Source: Technopolis, EEEP workshop participants survey

Discussions with the **academic secondees** reveal many benefits delivered for the individuals, both with regards their personal skills, networking, as well as changes – practical examples and illustrations - adopted in their **teaching materials** and **continued research activities**. Secondees also provided examples of the contributions made during their secondments to the industrial partners in **addressing real problems**. Many of the academic secondees mentioned they continued working on some of these real industrial problems with their students, upon returning from the secondment and fed back the results to the host industrial partners. Such work not only enriched the students learning experience, but provided a good foundation for **continued collaboration** with the industrial partners.

The EEEP was not designed to have a direct impact on the students, but used the **upskilling** of the **university staff as a multiplier** to have **indirect impact on the students**, especially on their employability due to the expectation of increased industry relevance of their studies. As a result of this design, **immediate short-term impact on the students is not measureable**.

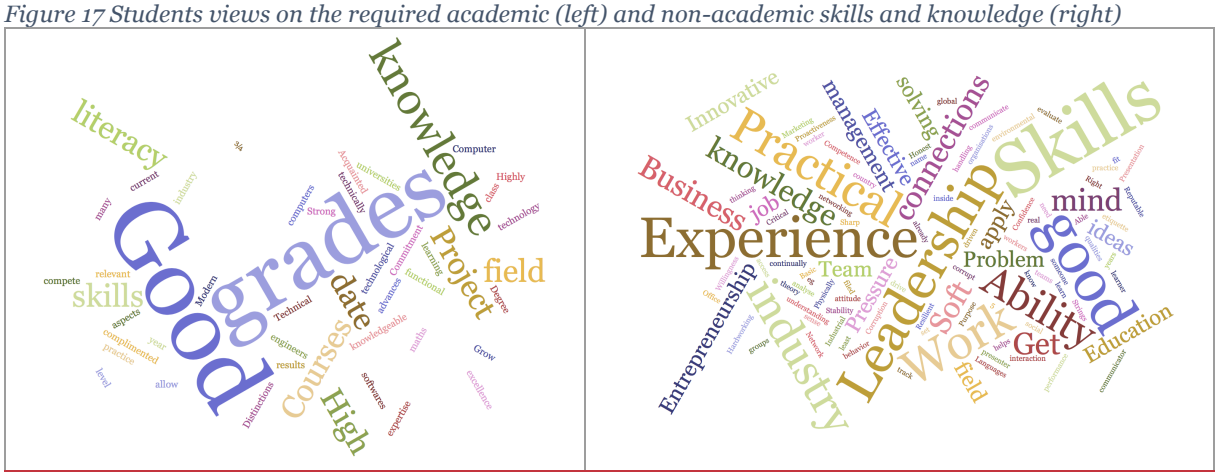
The EEEP was however beneficial as seed funding to kick-start activities. Lecturers, who have been implementing changes in the teaching materials and methods gave account of positive feedback from the students. The **new visual materials** for example help students better understand the practical use of the what so far was seen as a text book content. **Students** also have **better understanding** of the varying **expectations from industry** and the skills and knowledge required by the potential future employees.

> *'If the employers judge the graduates based on their skills, then having industry relevant projects, is a very good way to increase their employability. Students are also more motivated if they work on a project with societal relevance.' Source: interview with a secondee*

This positive change in the course content was confirmed by some of the students, who had classes taught by lecturers who went on secondment. These students with direct experience were very much in

favour of sending all of their teachers on secondments to renew the content taught, and they also advocate changes in the delivery method of their courses. Students are well aware of the outdated technology and machinery used and available at the universities and the major differences with their experiences in comparison to real industrial experience. Most of the **students** met during the field visits expressed a strong desire to **become entrepreneurs** after graduation. The illustration below shows what they believe is necessary to become successful in their future careers.

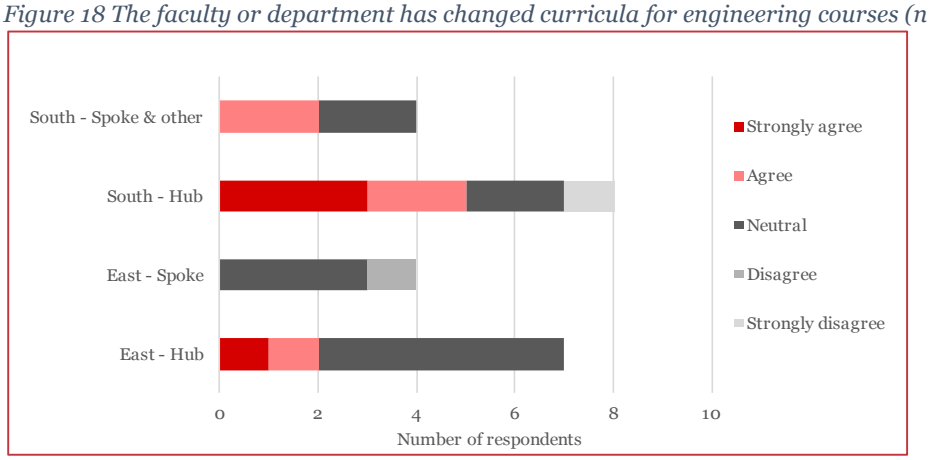
Figure 17 Students views on the required academic (left) and non-academic skills and knowledge (right)



Source: Technopolis discussion with student at the two hub universities. The image was created by using an online word cloud generator[18]

Individuals are inspired and willing to make changes, however for transformation to happen at an organisational level, further support would be needed. At the Southern hub due to the curriculum review undertaken, these changes will not remain isolated good examples on the level of individuals, but will be extended to the whole Faculty. With regard to other participating organisations, the impact stems predominantly from new guidelines or instructions prepared by the faculties/department regarding teaching methods (see Figure 16 - 83% agreed or strongly agreed with this statement). Although **curriculum review** could have the biggest impact, it is **resource intensive** and requires a strategic and structured approach with support from staff, management, accreditation bodies and policy-makers.

Figure 18 The faculty or department has changed curricula for engineering courses (n=23)



Source: Technopolis, EEEP workshop participants survey

The **workshops** have not only influenced the **teaching methods** within the higher education institutions, but had an impact on **networking** among the participating institutions. The hubs mainly engaged spoke universities based on prior relations, however there are also examples where the projects brought together university representatives who did not have high levels of collaboration.

[18] https://www.jasondavies.com/wordcloud/

The knowledge sharing activities reinforced networking within the regions and internationally Fundamentally the problems are rather similar in the different countries, and the mixture of universities – newer and older, traditional universities and more specialised universities of technology – provided a diversity of experiences and approaches for the discussions. This was very useful according to the participants. The discussions about harmonised approaches to teaching also highlighted the importance of **curriculum accreditation and international student mobility**.

Some of the contacts established remain active, and resulted in further joint activities between the HEIs. Through the contacts established, universities now have access, for example, to a broader pool of external examiners to draw on for their faculties. Continued networking is planned through the South African Engineering Education Network (SAEENET). At the same time institutions remain underfunded and this **limits the extent of further collaboration**. New relationships need to be nurtured and build on the initial momentum generated. Experience shows that once funding is finished, many of the activities reduce or completely disappear. There are many initiatives built on initial energy but sustainable results need long term commitment and support.

Impact on industry collaboration and technology transfer

As described earlier, there were major differences in engaging industrial partners, local and national stakeholders by the two hubs. The Southern hub put a major emphasis on involving a broad range of relevant stakeholders in the project implementation, the Eastern hub focused more on the international networking of academics. The primary objective of the EEEP projects was as per the title of the programme to enrich engineering education. As a consequence of the various tools used, **academy and industry had a lot of interaction**, especially during the secondments and some of the workshops. Therefore, technology transfer or rather **knowledge exchange** has happened, but this was not the primary objective of the programme implementation.

There is one exception, the University of Dar es Salaam. The University was already in the process of establishing an Innovation and Entrepreneurship Centre, with the aim to coordinate activities undertaken in the various departments and provide a structure to efficiently support the Faculty with translating research results into prototypes and practical solutions with industrial application.

The interaction between academics and the industrial partners has **increased awareness** of the benefits delivered through collaborative activities. The secondments created **win-win situations**, and the workshops enabled discussions on topics of mutual interest. All survey respondents unanimously agreed workshops facilitate an effective exchange of view between universities and industry, and they would be happy to participate in similar workshops in the future.

The seconded academics contributed to **solving real problems** in their hosts organisations, through joint activities tangible results were achieved – as demonstrated by the successful groundwater supply system at the University of Zimbabwe – and industry took the opportunity and contributed to the curriculum review. The revitalisation of the Industrial Advisory Board at the University of Zimbabwe is another very important step towards long-term strategic relationships between the University and key industrial partners.

Currently, academics who participated in the workshops have **very positive views** about the **impacts** the programme had on their own views regarding **university-industry collaboration** as well as the increased emphasis given to university-industry collaboration at the Faculty, in which they work. Among the survey respondents 87% and 83% agreed or strongly agreed with these statements (see Figure 19).

Figure 19 Impact on academy-industry collaboration

Statement	Level of agreement	Type of university		Total	Number of responses
		Hub	Spoke & Other		
Impact on the individuals					
	Strongly agree & agree	54%	33%	87%	24 (100%)

Statement	Level of agreement	Type of university		Total	Number of responses
		Hub	Spoke & Other		
I have changed my approach to university-industry collaboration	Neutral	8%	4%	12%	
I have established new contacts with other universities / industrial partners	Strongly agree & agree	46%	37%	83%	24 (100%)
	Neutral	13%		13%	
	Disagree	4%		4%	
Impact on the higher education institution					
The faculty or department has increased its emphasis on collaboration with industry	Strongly agree & agree	50%	33%	83%	24 (100%)
	Neutral	13%		13%	
	Disagree		4%	4%	
The faculty has created new support structures to facilitate collaboration with industry	Strongly agree & agree	33%	25%	58%	24 (100%)
	Neutral	29%	4%	33%	
	Disagree		8%	8%	

Source: Technopolis, EEEP workshop participants survey

To make the workshops even more useful and effective, almost half of the participants highlighted the need to **engage more industrial partners as well as students** in the discussions. Interviews reinforced these views, but also provided examples of academics visiting industrial partners more often since the programme. The precedent of successful secondments paved the way for increased collaboration, and created **shared understanding** between the university and some of their industrial partners.

These examples all highlight that the programme had an important contribution to make towards increasing the liaison between the universities – especially for the two hub universities - and their industrial partners. It helped demystify academy-industry relations, and made the first steps towards **trust building** among the partners. It **created links** that were not there before and established relations, that could result in substantial impact on the organisations if persistence prevails. The efforts of the University of Zimbabwe to set up **Industrial Research Chair** positions funded by industry represents another important step moving towards long-term strategic collaborations. The new Industrial Research Chair position has great potential as an exemplar to motivate further collaboration of a similar nature. Due to the commitment secured from Zimplats a new position was already created and the first Industrial Research Chair appointed.

Impact of the pilot EEEP

The EEEP delivered clear near-term impact **on teaching methods, curricular and behaviour** within the participating higher education institutions. Stakeholders reported:

- Increased awareness of alternative teaching and learning methods
- Implementation of changes in teaching methods and curriculum: Impact stems predominantly from the new guidelines or instructions prepared by the faculties/department, but at the Southern hub
- Increased networking and knowledge sharing on topics of common interest between institutions
- Secondments had an impact on the mentality and outlook of individuals, which also resulted in enhanced personal skills and provided materials for teaching
- Establishment of ongoing working relationships with industry partners

Curriculum reviews which have a large impact, are resource intensive and require support from the entire system from lecturers, university management and policy-makers. The EEEP was not designed to have a direct impact on students, instead it used the upskilling of the university staff as a multiplier to have indirect impact on the students.

Individuals are inspired and willing to make changes, but for transformation to happen at an organisational level, further support would be needed. 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.

The EEEP enhanced collaboration and **knowledge exchange between industry and universities**. The secondments were direct examples of this, with university staff learning from industry as well as contributing to solving problems within companies (tangible results achieved). 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**. The programme resulted in increased the awareness of the benefits that can be delivered through collaborative activities and made an important contribution towards increasing the liaison between the universities and their industrial partners. For example, 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 contributed to the implementation an 'Innovation and Entrepreneurship Centre'.

4 Recommendations, future considerations for the scaled up Programme

4.1 Lessons learnt from the implementation of the EEEP, IAPP and comparator programmes

The lessons learnt, key barriers and success factors are described in this chapter. They are brought together using all of the elements of this work. This includes a consolidation of the results from the evaluation of the EEEP pilot projects, consultations and review of other international examples from the Academy's portfolio, as well as an analysis of the five comparator programmes. The following figure provides an overview of the five comparator programmes.

Figure 20 Overview of the comparator programmes

Name of the programme	Geographical area covered	Subject field	Level of education addressed	Funded activities
KEMRI|Wellcome Trust Research Programme	Kenya, and the University of Oxford as UK partner	Medical research	PhD training and post-doctoral re-training	(1) Out-reach activities (2) PhD training and retraining (3) Community engagement
AIMS – Cooperative Senegal pilot – funded by MasterCard Foundation	Run in Senegal with students from Senegal, Cameroon and Rwanda	Mathematics	Targeting Master students	18 months long cooperative studentships
PASET –funded by the World Bank	21 African countries and representatives of Brazil, China, India, and Korea	ASET - Applied Sciences, Engineering and Technology	Full spectrum of education from Technical and Vocational Education and Training (TVET) through upper secondary level to post-graduate level research	(1) Support training of at least 10,000 new PhD holders (2) Post-graduate scholarship programme (3) Students in ASET programmes (4) Postgraduate studies and applied research (5) Develop at least five regional TVET centres of excellence (6) Regional QA development (7) High quality data systems and benchmarking
Strategic Partnerships for Higher Education Innovation and Reform (SPHEIR) – funded by DFID	Low-income and middle-income countries located across Sub-Saharan Africa, Asia and the Middle East, including most of the countries DFID works with	No restrictions, all subject fields	University level education	(1) HE delivery: improving the content and delivery and teaching methods within single departments, faculties or universities, or collaborative across institutions or even countries (2) HE enabling systems: strengthening system and institutions, addressing issues such as governance, quality assurance, accreditation and financing
Development Partnerships in Higher Education (DelPHE) – funded by DFID	All DFID priority countries	No restrictions, contribution to the MDGs	Higher education institutions	(1) Funding for research capacity development at departments (2) Improving the quality of curriculum development and delivery

4.1.1 Key barriers, risks and challenges

1. The economic and social framework conditions

The economic situation, has a major influence on the levels of industrial activity and the funding situation of the universities, setting the framework conditions for engineering education and graduate employability. Many of the problems – such as outdated equipment, problem of international brain drain, difficulties of retaining highly qualified staff in the public sector due to low wages - require systematic changes, and cannot (and should not) be solved by support programmes alone. A further problem relates to the sustainability of achievements. Without further support – either from local or international sources – the sustainability of results is questionable.

The economic situation in many of the countries also prompt the rethinking of requirements regarding the realistic contribution that can be expected as input to the programme. For example, a requirement to contribute to a scheme through other than in-kind contribution might not be feasible.

Figure 21 Overview of the main demographic and economic indicators in the SSA regions

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

Source: Technopolis

2. Communication from the Academy on project objectives

There seemed to be a lack of clear communication from the funder, particularly during a pilot and scale-up activity. This creates divergent implementation. Inconsistent use of the funds makes it difficult to understand and unpick the success factors. For the pilot phase, this can be considered as planned experimentation, and can help to benefit the future programme design, where final decisions are made on delivery mechanisms. However, for the future, more specific decisions should be taken on how to develop the activities further, what to communication to the funded projects, and the support given to ensure there is common understanding. This is especially important as a larger project portfolio is now being managed by the Academy.

3. Timescale of the project vs the objectives set

Some of the objectives set by the project require a longer time frame to realise. The universities consulted all have their set ways and frequency of implementation (for example when they carry out a curriculum review). Therefore, ensuring that EEEP activities are harmonised with already set cycles would be an important enabling factor for successful implementation.

4. Capacity to transparently manage the financial aspects of project implementation for the hub universities

Many of the universities participating in the programme lack sufficient experience to plan and budget international projects, especially with other stakeholders involved (i.e. industry and academia). There may be examples of where current financial practices are not in line with the accepted international standards of auditing. In addition, the financial management was, in this case, separated from the project implementation within the organisations, which resulted in inefficiencies according to the final evaluation of the Southern hub.

5. Difficulties in undertaking international mobility

Although it was planned to have a lecturer exchange between Zimbabwe and Namibia, due to the difficulties of obtaining a work permit, this activity did not happen.

The lack of international accreditation and harmonisation of the study programmes are barriers to increased mobility of students. There are however international activities that aim to increase the permeability of the different systems, including some of the funding streams as introduced in the comparators programme descriptions as well as the Africa Catalyst programme of the Academy.

Figure 22 International schemes and regional engineering associations in the SSA regions

Main section	Indicators	West SSA	East SSA	Central SSA	South SSA
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)
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)

Source: Technopolis

6. Mismatch of interests and objectives between academia and industry

Company buy-in is hard to secure for collaborative activities in the field of education, especially without prior examples. This is not such an issue for the IAPP projects, where the research element – a more commonly used and known form of collaboration - can bring industry and academia together. Collaboration in the field of education-related activities does not create obvious short terms gains. Therefore, such collaboration must go together with a clear value proposition, where industrial partners can recognise the pay-off for their time and resources devoted to the project participation.

The way, the Southern hub approached the potential partners built on this approach. They emphasised, that through the project they do not only plan to empower the academics, but the secondments will also help to close the gap between academia and industry, thereby deliver many benefits for the industrial partners such as through solving problems they face. The first point of call was based on existing

relationships, where prior knowledge helped building trust between the partners. Over time, the level of engagement from industrial partners grew, together with the number of workshop participants. The successful implementation triggered the interest of other partners as well.

Figure 23 Key stakeholders and their position

Main section	Indicators	West SSA	East SSA	Central SSA	South SSA
 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]
 Engineering associations	Presence of engineering associations	Several examples of engineering associations are listed in the full description of the regional fiches, presented annex			
 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[19] 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**
 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 many 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

Source: Technopolis

4.1.2 Key success factors

1. Project champions and creating ownership

The engagement of the right individual who is highly motivated to drive the activities forward, can overcome the challenges presented and have the authority to initiate change. This is often referred to as a champion, someone who is accepted and has dedicated time for the project. This is a key element of a successful project implementation. The role of the champion has to be combined with authority and freedom of making decisions, enabling the opportunity to move forward. For example, the engagement of the Dean of Engineering Faculty from the University of Zimbabwe ensured that all departments within the Faculty were involved in the project implementation. If the campions are chosen from individual departments and do not have the authority to gain buy in, the projects have great difficulty succeeding.

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

Partnership for Skills in Applied Sciences, Engineering and Technology (PASET) was launched in 2013 by African governments with support from the World Bank. The success of PASET is advertised as linked to its solid ownership by African governments, private sector, and regional organisations. 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.[20]

PASET function by 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.

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.

2. Teaming up with other initiatives and relevant stakeholders to multiply the project effects

Securing industrial commitment and reducing the costs of workshop organisation, while increasing the impact on networking can be done through through teaming up with other international conferences or events. This can increase the cost efficiency of the activities. Although joining large conferences has a small risk of derailing the focus of the discussions to suit the main conference agenda better, with careful planning, the right balance can be ensured, and multiplier effects utilised. This is an approach that has been used by other programmes as well.

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.

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.

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.

Building local engineering capacity that drives economic development is the primary focus of any Professional Engineering Institutes (PEIs), including those in SSA. The Academy's declared aim with its international industry-academia programmes is very much aligned with this goal. A closer engagement between the Academy and PEIs in SSA offer a unique opportunity to mobilise individual members, engineers and organisations, to learn about industry-academia partnerships in general, and participate in academic secondments in particular, and thus jointly contribute to upholding the quality of the engineering profession in SSA.

PEIs are thus a multiplier to provide a structured access route to relevant engineering companies and support university engineering Faculties to organise industry and academic secondments. In addition, due to their high-level commitment, PEIs could also contribute to prioritise industrial areas and project topics for industry-academia engagement (e.g. for solving specific challenges and outlining gaps in research capacity) so that efforts are directed where the needs are the greatest. Securing a 'buy-in' from key national partners would enhance the relevance, success and sustainability of the Academy's programme.

[20] 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

4.2 Recommendations for the scaled-up programme

The recommendations and main considerations of the study focus on:

- Of how any scaling of the international programmes can have an embedded UK research links
- Of how any scaling of the international programmes will be ODA compliant due to the nature of UK Government spending
- The implementation of the scaled-up Programme both by the Academy and the universities involved, including a 'How to guide to academia-industry collaboration'

4.2.1 Embedding UK research links

For the future programme, ensuring there are benefits delivered to the UK is an important aspect. Understandably the donors wish to see value generated for their funders. This aspect has already been implemented in the IAPP projects, where the partners from developing target countries have UK partners engaged in the project implementation. However, the target countries of the two programmes differ. There are significant differences in the level of technology between the UK and the EEEP target countries, as well as problems that need addressing. The shortage of high level knowledge on advanced engineering makes **finding a mutually interesting topic** between a UK partner and a SSA partner somewhat challenging. This is an important consideration for the future scheme, and an area where the IAPP's project selection model could be considered.

There are clear benefits for the Sub-Saharan African countries in hosting a Visiting Fellow – benefits are numerous both for staff and students - but for the programme to work, the benefits need to be mutual. Some of the universities already use international experts for their curriculum reviews, therefore they have a lot of experience in engaging international experts. The pilot programme only engaged one UK Visiting Professor. His experiences were very positive, however his personal motivation and willingness to visit a university for a short period are not transferable. However, **individuals can be incentivised** to consider participation, and successful programme implementation requires a structure and a clear value generation path. This can be built up overtime, showing successful examples of past pioneers.

There are many options available for engaging UK Visiting Fellows in a future programme. Possibilities vary depending on the time availability and the level of involvement expected. Assuming, the focus of the future programme remains on education, there are many options the programme could incorporate:

- Provision of **single lectures or full courses online** – some of the universities already have access to virtual classrooms that can be used for these purposes
- **Visits in person in SSA countrie**s for a condensed time period to carry out a specific task - e.g. a review of the faculty with interaction mainly with the staff instead of the students, similarly as it was used in the pilot programme - or spending a longer-time period on the visit and contributing to course delivery
- Focusing on **student exchange** instead of staff visits, where the UK partners and their counterparts would host the students (both UK and international) for a set time period. In this case the students would act as change agents. The Swedish KTH has such a student exchange with a university in Namibia, and they wish to continue these activities based on the successful implementation so far. There are also examples of German students spending a time period in India, and upon return having a major multiplying effect of full classes

If the Visiting Fellow option is chosen, there is a need to find the **right people with the right motivations** who would be willing to get involved in these activities. If there is exchange involved in the programme, that has to take the form of **experience exchange**. Past experiences show, that there is a tendency for European experts to go and try to tell the SSA universities what to do. Furthermore, differences in the salary levels of a Visiting Fellow and the local staff might create a situation of huge imbalances. Therefore, it is of utmost importance to engage Visiting Fellows who are interested in learning themselves, and approach the involvement in the programme with an 'equal experience sharing mood', as one of the interviewees put.

The Royal Academy of Engineering has a reputation for engineering excellence within the UK and internationally and is well known. Many of the senior academic and industrial engineers the study team met during the field-trip in SSA had a degree from a UK institution. One of the challenges identified in the programme is the lack of strong incentives for industry fellows to engage in secondments in academia. The Academy could usefully **leverage its excellent 'brand'** and offer industry (seconded) fellows that title 'Royal Academy of Engineering Visiting Industry Fellow' or something similar. This already happens in the UK VP/VTF scheme. The possibility was discussed in the field trip with stakeholders as well as consulted members of the Academy's EEEP and IAPP steering group. This kind of association with the Academy can be considered extremely prestigious. In addition, UK Visiting Professors and Visiting Teaching Engineers could also be offered an **RAEng 'badge' as an added incentive** to engage with international secondments.

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.

Another important aspect of embedding UK links in the programme, is the lack of contacts of some universities in the UK. Therefore, there is a need for contribution from a **well-established intermediary** who can **help link the SSA universities with UK counterparts**. The EEEP could potentially use the same model as IAPP with a call for papers and selection for funding. This would also provide a basis for potential matchmaking i.e. submitted papers could be matched with interested Fellows to facilitate creating linkages between the potential SSA and UK partners.

The **KEMRI|Wellcome Trust Research Programme (KWTRP)** is a health research unit of excellence. The key stakeholders are the Wellcome Trust, the Kenya Medical Research Institute (KEMRI) and the University of Oxford.[21]

- 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 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.

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.

4.2.2 Recommendations regarding the implementation of the scaled-up Programme

Based on the evaluation findings, our recommendations focus on the following. The recommendations are presented in the order of importance, starting from the 'must have' considerations finishing with the 'would be useful to have, if resources allow' suggestions.

1. **There is a need to develop a programme logic at the funder level to ensure synergies and complementarities among the programme portfolio**

There is a need to develop an overarching overview of the industry-academia support programme portfolio, within the Royal Academy of Engineering, to which everyone can subscribe. Once established, this can be understood and used by all involved staff (and stakeholders) to implement the calls and programmes. Coupled to this, a transparent governance structure should be in place. This should be supported by declared selection criteria for the projects put forward for funding. These elements should feed into the currently available three important approaches that support the growth, quality and

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

professionalisation of engineering in developing countries. The following table gives an example of high level objectives which relate to these three current approaches (although are not mutually exclusive).

EEEP	IAPP	Africa Catalyst
Increasing the employability of engineering graduates in developing countries through reinforced industry-academia collaboration in the field of education.	Increasing engineering research capacity, related to industrial growth in developing countries through fostering collaborative research that represents mutual interest.	Recognising the quality of engineering research and education through supporting profession bodies and associations.

Once a full programme logic has been designed, at the strategic level, all subsequent decisions on funding projects/programmes, applications, selection, monitoring and evaluation can be guided by common principles.

2. A well-functioning reporting and monitoring system should be established

To increase the transparency towards the donors as well as to increase the efficiency of project implementation, allow for changing and corrections to be made in time by the programme management, there is a need for a monitoring system to be put in place.

Basic points for successful monitoring

- Build simple, user-friendly monitoring systems into everyday activities, collecting data at the most natural point
- Get commitment from those collecting the information, by explaining why they are doing it
- Make sure that everyone responsible for monitoring has clear and consistent guidelines
- Make sure that monitoring records are completed fully and accurately – people may not regard it as a high-priority activity
- Give people collecting the information feedback on the results of their monitoring, and how it is being used to make the organisation more effective
- Check that the project is not collecting the same piece of information more than once

Below we showcase a set of indicators from which a selection could be relevant based on the current programme logic.

Figure 24 Potential indicators for the EEEP and IAPP projects

Category	Topic / level	Indicator	IAPP indicator*	Frequency of data collection
Contextual indicators				
Context indicators	Economic indicators	– GDP, growth – GERD – Government expenditure on education	Should be considered	At the beginning of the programme, and then annually
	Social indicators	– Population – Unemployment – Educational level - Tertiary education attainment (gender distribution, subject fields)	Should be considered	
	Sectoral indicators	– Number of HEIs in the country – by type and specialisation – Ranking of universities – Nr and types of engineering programmes available – Enrolment in engineering study programmes	Should be considered	
Programme-related indicators				
Input	Programme level	– Nr. of institutions who are interested in participating in the programme (by type / location) – Available programme budget	Should be considered	At the beginning of the programme

Category	Topic / level	Indicator	IAPP indicator*	Frequency of data collection
		– Number of proposals received, projects selected, funding requested and granted (by type institution / location)		
	Project level	– Nr. of lecturers interested in participating in the project activities (by type, institution etc) – Nr. of industrial partners who committed to engagement (by type)	Should be considered	At the beginning of the programme, and then at project milestones
Output	Education	– Nr. of courses with renewed course content – Nr. of students exposed to new course content (type, gender.) – Nr. of staff secondments (by type.) – Nr. of student attachments (by type, gender.) – Nr. of lectures delivered by industrial fellows	– Number of new teaching methods – Number of new courses – Number of exchanges – Number of professional involved – Number of students involved – Number of engineering courses affected – Number of internships – % teachers involved in Industry activities – Number of Industrial engaged in Academic activities – Number of visit/workshops with tech transfer	At project milestones, but linked to the semesters/trimesters
	Research	– Nr or academia-industry collaborative projects initiated – Income generated from these projects – Nr. of student projects delivered with industrial mentoring – Nr of industry visits	– Number of industrial projects/collaboration – Number of exchanges – Number of professional involved – Number of students involved – Number of internships – Number of research projects/collaboration	At project milestones
	Dissemination and knowledge exchange	– Nr. of workshops organized (type, location.) – Nr. of participants (from academy, industry, national and international stakeholders) – Nr. of dissemination materials produced (by type, audience…)	– Number of workshops held – Number of people (type) attending to the workshop – Number of Engineering sectors studied – Number of active partners – Number of conference/industrial workshops – Number of Academy fellows involved – Number of workshops held – Number of visits in UK – Number of visits in relevant universities/companies – Number of UK community engaged	At project milestones
Outcome	Education	– Student satisfaction with the courses delivered (by type of lecturer) – Increased in knowledge, skills and competences related to new course content – Increased interest for further student attachments (by industry)		At project milestones
	Research	– Enhanced expertise of academic staff (self-reported / student reported) – Nr. of new collaborative research ideas generated – Changed attitude and perception to working with industry (for academics) – Changed attitude and perception to working with universities (for industry)	– Number of patents – Number of co-publication of scientific articles – Number of spin-offs/prototype/license	At project milestones
	Dissemination and knowledge exchange	– Increased interest from stakeholders in engaging with university – Nr. of new partnerships initiated	– Perception of knowledge transfer between Industry/Academia	At project milestones
Impact	Education	– Rate at which students gain employment in engineering-related industry – Nr. students hired by firm in which they completed their attachment	– % graduated student finding a job in engineering field – Perception of the quality of student employability	Annually, as relevant

Category	Topic / level	Indicator	IAPP indicator*	Frequency of data collection
		– Nr. of graduate student start ups – Employer satisfaction with students		
	Research	– Increased research output (related to industry projects) – Value of research grants gained from academy industry collaboration	– Perception of the quality of research – % of secure research funding	Annually, as relevant
	Dissemination and knowledge exchange	– Increase perception of value of academy-industry collaboration (wider level)		At project milestones

Note: *Some minor rationalisation and reconciliation has been done on the IAPP indicators.

The above indicators are suggestions only, and the final set of indicators has to be established in line with the objectives of the programme. Developing a monitoring system is much simpler when a programme has been designed with a clear framework since if the objectives are clearly set out, then in principle the data needed to judge whether these are being achieved should fall naturally from that. Considering that the phase two EEEP projects are just in the process of being launched, it is important to bear in mind, if data is not collected at the relevant time it may be impossible to reconstitute them later.

The use of the SMART - criteria: Specific, Measurable, Achievable (or acceptable by those responsible for their attainment, attainable), Realistic (or reliable, relevant) and Time-bound (or sensitive, so that the expected time scale for impact is understood) - and RACER (criteria: Relevant, Accepted, Credible, Easy and Robust) indicators need to be combined with purposeful reporting.

The pilot phase required bi-annual reporting, which seems a bit hands on, but combined with a reasonable structure and length requirement should be easy to comply with. However, the pilot project also required detailed documentation of the different activities undertaken. The purpose of these documents (e.g. on the secondment and workshops) was less clear. Using the limited resources to their maximum value could involve preparing documentation on the different activities organised and secondments undertaken in a format, that is ready for wide circulation. Therefore, such short, to-the-point presentations of experiences could be turned into useful communication tools for the projects.

3. The project length and amount of funding should be reconsidered

To foster change, long term commitment is more important than resources provided during a short period of time. Instead of the two-year long projects, a new project structure should be created, which builds on a two-stage approach. Understanding that universities learn by doing during these projects, ideally the project implementation should incorporate a short - 6 months long - inception phase, where the beneficiaries are asked to work out their proposals in more details, the exact timetable of project implementation, reconfirm the commitment of the key stakeholders who should be involved in the implementation, and carry out a risk assessment. Thorough planning during the inception phase, helps builds solid foundations for successful project implementation. In line with the objectives of the projects, the project implementation phase of the project should last 3-5 years. It is crucial, to set a detailed timetable, introduce milestones and measurable targets, ensure that the roles and responsibilities are clarified. In the extended time frame, it could be relevant to include even longer term objectives which include a vision for acquiring international accreditation. If these are considered early on, it is more likely they could come to fruition.

The extended timeframe also involves a reconsideration of the project funding. The grant size should foremost correspond to the objectives set, which have to be combined with realistic resource allocation. Due to limited funding available, the creation of a fragmented landscape through many small grant provisions should be avoided. Unless addressing very specific problems and projects, as it is done in the IAPP projects, the fragmentation will result in limited impact delivered.

SPHEIR programme example: 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.

4. The implementation model of hub and spoke universities was useful for the pilot phase, but should be reconsidered for any follow-up activities

From a programme management point of view the hub and spoke model is probably a more pragmatic way of managing the programme from afar, where only two institutions were involved directly. However, the effectiveness of engaging a large number of HEIs in a rather fragmented way is questionable, especially if the results and impacts are expected to reach beyond awareness raising and networking.

The workshops that were organised as part of the pilot projects were instrumental in building a network of universities and provided a very useful platform for experience sharing. However, for a scaled-up programme with many beneficiaries, such dissemination sharing could take place among the beneficiary universities to give another boost to their project implementation, instead of involving many new spoke universities with marginal contribution to the project implementation. This is particular true considering the resources available for the project.

If the hub and spoke model is sustained, it is vital to engage the spokes with distinct tasks and clear expectations. They need to become part of and contributors to the project delivery.

An alternative to the hub and spoke model is one where a larger number of universities are provided with some project funding (extending the number of hubs) and the networking takes place between these funded institutions as part of the programme. This takes a non-hierarchical approach to exchange of experience and supports a peer learning network. It would increase the fragmentation of funding but at the same time create a wider network of "capacity-ready" institutions who could work together where common objectives are identified.

The **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.

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

Several features of the **DelPHE programme** aimed to support this sustainability of the partnerships:

- 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 (198 of 200) completed the programme period and a 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.

5. Managing expectations and contributions of the partners

More time should be dedicated to understanding the needs of the industrial and academic partners to develop effective and long lasting links/collaboration between them. However, among the challenges are time and funding i.e. availability of people from both the academia and the industry to work together and funds to support joint activities and/or participation of the agreed activities. The industry and the higher education institution should therefore solicit funds from within their own resources to support their activities.

This is also an important consideration for the different project activities, especially for the organisation of the secondments. Regardless of the exact length of the secondments, managing the expectations regarding the results and possible outcomes of the secondments of all partners involved is a key task. Ensuring a shared understanding before embarking on such joint activities is a prerequisite to build successful long-term relations.

The **AIMS – Cooperative pilot** in Senegal was developed by using a reflective programme design. Some of the key lessons are summarised in the box below.

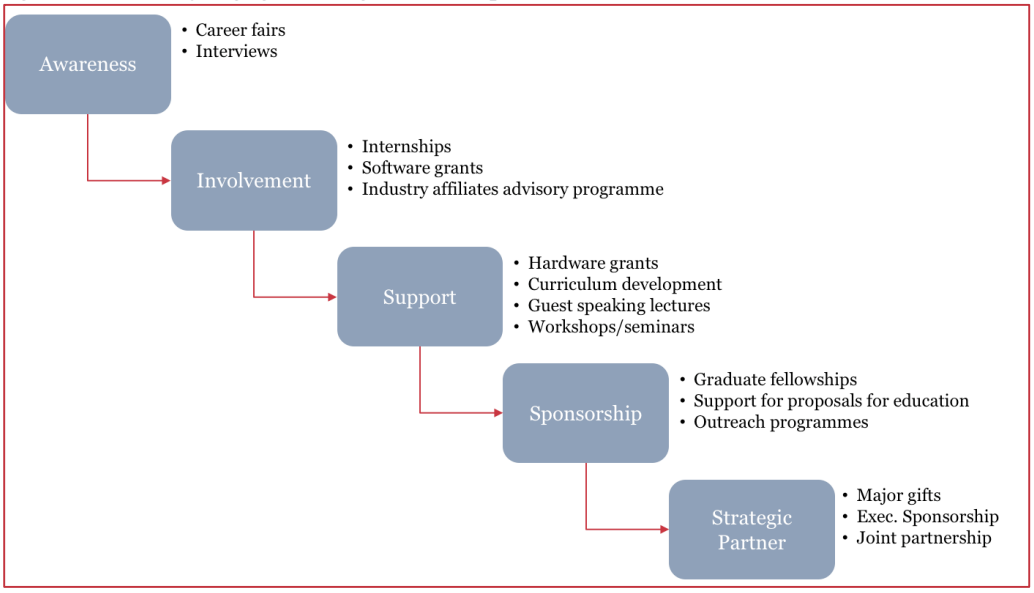
- Flexibility and adaptability – the coop employers have diverse requirements and the students have to settle into these different environments. This means the AIMS team need to be responsive through the process. In addition, with careful feedback, it is possible to adapt the curriculum in real time 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 fully. The MasterCard Foundation stipulate certain conditions such as entrepreneurship training

6. Provide guidance to foster the development of successful academia-industry partnerships

There are many different types of academia-industry relationships and an increasingly growing literature on discussing the benefits and barriers, key success factors and good practices of how why and how to establish academia-industry relations. There is cooperation in education and training through various courses and/or study programmes linked to business' needs, visiting business representatives, students' placements, fellowships or traineeships. There is cooperation which takes place in research, and research result commercialisation, or through start-ups and spin-offs, often engaging staff mobility. There is collaboration in governance where industrial representatives become university board members. Both higher education institutions and companies have been increasingly involved in upskilling of the adult population, or of their employees respectively.

For the purposes of the Academy's programmes, collaboration around education and research are of key importance, however they cannot be singled out from the complex relationship academy has with its external partners. A recent study that explored the impacts of university-business cooperation, used the following model to show the different levels of industrial engagement in academic activities. The original model was adapted to the EEEP programme.

Figure 25 Levels of engagement by industrial partners



Source: European Commission, Measuring the Impact of University Business Cooperation, (EAC/23/2012)

The step by step approach highlights, that successful, long-term sustainable partnerships need to be built incrementally over time, by working together to develop a common language and working method with shared goals. All stakeholders involved have an important role to play establishing mutually beneficial relationships. Another key issue is the creation and sustainability of new partnerships. It is easier to work with established relationships, but increasingly important to widen the pool of industry partners in order to ensure that academics and students have access to opportunities (and vice versa). Working on the development of new partnerships could be an objective of the programme.

A recent study on the State of University-Business Cooperation in Europe[22], as well as the Dowling Review[23] in the UK reinforced that people are at the core of any academia-industry collaboration, driving it forward making the relationship a success. Therefore, incentives play an important role in promoting academia-industry relations. The rewards and incentives can take many form and are not just at the individual level (and not just for academics) but they can be present also at the institutional or organisational level. Possible incentives at different levels include:

- National, regional and institutional stakeholders can be involved in incentivising all types of activities for the benefit of higher education and industry. Public authorities can devise strategies, create favourable framework conditions and provide support schemes and incentives
- At the institutional level, collaboration can be recognised and rewarded through performance contracts, awards, time or more flexible arrangements for example. These can be summarised as compensation, empowerment and life work balance. Linking together rewards and incentives to create a more conducive and joined up approach to stimulating academia-industry collaboration can be beneficial for all those involved
- For industrial partners engaging in academy-industry collaboration has a long-term incentive through business growth and value creation. However, there are possible incentives to consider short term at the level of individuals as well. For example, depending on the national requirements of professional development in the field of engineering (i.e. registration for licence), activities delivered towards academic partners (e.g. mentoring student projects or delivering special industrial modules in the academic curricula) could become recognised achievements and account towards fulfilling one's obligation set in the country's Continuing Professional Development (CPD) framework.

[22] European Commission, DG EAC: Final Report - Study on the cooperation between Higher Education Institutions and public and private organisations in Europe, 2011

[23] The Dowling Review of Business-University Research Collaborations, July 2015

For example, in Tanzania the Engineering Registration Board's Code of Ethics for Engineers states the following:

"An engineer shall continue his professional development throughout his career and shall assist and provide opportunities for the professional advancement of an engineer or engineers under his supervision."

Practicing engineers should therefore manage their CPD in such a way that it does not only benefit them alone but it is also credible to other interested parties and brings credit to the profession as a whole. They should ensure that they share their knowledge and expertise with others in their work places. CPD is not only beneficial to the individual engineer, but to the employer and society as a whole.

To make collaborative activities a success, there are number of steps different stakeholder can take to foster academia-industry relations. The chart below was adopted from the State of the UBC study[24], which created these recommendations based on the analysis of over 6,000 survey responses from over 30 countries exploring the main barriers and success factors of university-business cooperation.

Figure 26 Recommendation for stakeholders – adopted based on the findings of the State of the UBC study[25]

HEIs (Rectors)	Academics	Business	Society (Policy makers)
1. Create implementation strategies (e.g. incorporate activities as part of academic assessment) 2. Reduce bureaucracy within the HEI to foster collaborative activities 3. Put more focus on relationship development (especially trust) between academics and industrial partners as this drives collaboration **Bonus:** Promote the benefits of collaboration (monetary and non-monetary)	1. Seek opportunities or invite industry to partner in research projects 2. Proactively seek opportunities to meet relevant contacts within industry, e.g. through the technology transfer offices, student attachments 3. Seek opportunities to engage with business in curriculum development and delivery	1. Proactively seek opportunities to meet relevant contacts within academia 2. Seek better understanding of the motivations of academics and HEIs 3. Seek to partner on relevant projects or provide financial contribution for collaborative activities **Bonus:** Employ those who have worked within academia to liaise with academics	1. Funding is working in removing barriers to academia-industry collaboration (keep doing it) 2. Develop programmes that fund relevant research and promote the benefits of academia-industry collaboration 3. Provide funding for the establishment of dedicated support structures (e.g. programme, contact person or agency) to enhance collaboration between academia and industry

7. Students should be more involved in the project activities

If the programme's main objective is to reduce the skills gap and increase the employability of graduates, then the activities undertaken should directly target students as well. The benefits and disadvantages of the secondments and workshops have been discussed at length in the report already, therefore below we highlight some additional examples that could be considered as complementary activities to increase the engagement and impact on students.

[24] ibid

[25] ibid

Figure 27 Examples of potential project activities with impacts on students

Suggested programme activity	Direct benefits	Indirect benefits (medium term)	Indirect benefit (long term)
Industry fellows / Visiting Professors	• Teaching enriched with industry examples • Student projects, mentoring	• More industrial-relevant curriculum • Problem-based learning • Placement opportunities	• Increased employability • Potential spinouts
Staff attachment to industry	• Staff "reality check" • Sensitisation to needs of industry	• Improved teaching • Student awareness of commercial issues • Placement opportunities	• University-industry relations strengthened by new generation of graduates
Student placements in industry	• Hands-on experience of world of work (reality check) • New ideas for projects	• Contextual development of core technical skills • Improved soft skills • Increased sense of purpose	• Increased employability
International student exchange	• Access to more advanced equipment, facilities • Experience sharing	• Improved soft skills (incl. inter-cultural skills) • Knowledge and attitude	• Increased employability
International staff exchanges	• Staff upskilling • New/reinforced relationships	• Improved teaching content and delivery • Advanced research activities	• Increased employability
Final year student projects / student competitions	• Experience with project work • Motivation • Group working	• Improved soft skills • Increased sense of purpose	• Increased employability
International accreditation, transferability and recognition	• Confidence in quality • Recognition of results	• Transferability • Increased mobility of students	• Improved employment opportunities

Source: Technopolis (based on the discussions and ideas from the Birmingham Visiting Professor's Conference)

8. Provide opportunities to showcase success stories and increase the awareness of the programme

In line with the recommendation regarding the use of reporting materials for external purposes, there is also a need to increase the awareness of the programme among the potential stakeholders. Increased awareness, especially when already building on successes that are available to showcase will help engage more and relevant stakeholders within the target countries. Such activities do not have to be at a large scale, but small efforts can help revitalise relationships and provide a bigger pool of potential partners.

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