The Role of Tertiary Education Institutions in the Development of Technical and Technological Capabilities for Employment Creation in Eastern, Southern and West Africa: Selected Case Studies

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CHAPTER 1

1.0 Background

African institutions of tertiary education have played a significant role in developing initiatives aimed at the creation of capabilities for agricultural and industrial innovation in the last four decades. In the preparation for the ADEA Trienniale in 2012, the team that has produced this report was commissioned to assess the role of the regional policy bodies, regional research networks and a selected number of tertiary education institutions in the creation of technical and technological capabilities aimed at promoting employment and innovation in the region. Given time limitations only three out of the five regions of Africa were chosen i.e. Eastern, Southern and West Africa. The study started with a survey of the regional and sub-regional policies of the ADB, AU, NEPAD and some regional economic communities on science technology and innovation and their guidelines to national authorities on how to harness national resources for technical and technological innovation in various sectors of the African economy. The majority of these cases put emphasis on links between research institutions especially universities and industry. Building on regional policies the team undertook in-depth studies of university industry links and the role of three tertiary education institutions in knowledge creation and application in science technology and innovation.

1.1. Objectives of the study

The main objective in studying the three institutions was to find out what contribution each has made over the last twenty years in building technical and technological capacity and capabilities in their respective countries that may have contributed to the enhancement of science, technology and innovations, which could have contributed to employment creation, food security and poverty reduction.

This report contains three in-depth studies of tertiary education institutions (a) The Kwame Nkrumah University of Science and Technology (KUNST) in Ghana; (b) the Jomo Kenyatta University of Agriculture and Technology (JCUAT) in Kenya and (c) the Polytechnic of Namibia (PoN). These institutions were selected because they were at different levels of development and were addressing similar issues. KUNST started in 1952 while the other two were formed in the early 1990s. However they all share the vision of becoming centres of excellence in scientific and engineering research and teaching and aim at meeting the growing needs of productive sectors in their countries.

1.2. Summary of the Report

Chapter one is the introduction, chapter two examines the links between industry and universities as channels for technology development and innovation with general conclusions
that the three case studies, just like most African Universities, have not had robust links with industry that are driven by the need to create synergies for technological change and innovation. Chapters three, four and five highlight in detail the contributions made by all the three institutions and document some bold steps that have been taken by the Jomo Kenyatta University of Agriculture and Technology (JKUAT) in Kenya and the Kwame Nkrumah University of Science and Technology (KNUST) to foster links with farmers and industry. All in all they still need to push the frontiers of knowledge to higher levels by making knowledge accessible to producers instead of only providing access to their technology products.

In order to move a step further in that direction there is need to adopt an ‘innovation systems approach’ which according to Opondo and others\(^2\) is based on the assumption that an effective innovation system is one that allows the flow of information between actors facilitating creation of new knowledge and its application. The links that we have covered in chapters 2, 3 and 4 between universities and productive sectors, do not have that kind of impact or effect. Universities produce goods for communities rather than produce the same with them. This does not lead to transfer of knowledge or broadening of the technology base in these communities. In chapter 2 we also raise the issue of lack of Industrial Research Information Systems (IRIS) through which demand sectors can identify existing capacity within research institutions. Problems of the way research is organized in tertiary institutions; how time is allocated between the so-called core functions of these institutions and collaborative activities between them and industry and issues of reliability, predictability and trust have been identified as barriers to effective innovation systems within tertiary institutions. In chapter 2 we propose how to overcome these and other barriers identified.

Each of the three institutions has its own background, strategic plan and profile of activities. KNUST was formed in 1952 five years before Ghana’s independence, as a college of technology. It attained university status in 1961. Between the year 2000 and 2010 it graduated 42500 students. Although it has not conducted any tracer studies of its students, national statistics show that 71% of all graduates from Ghanaian universities got jobs within the first five months of graduation during the period while 29% took longer than a year to get employed. The Chapter on KUNST notes however that engineering graduates from the universities face stiff competition from those from the polytechnics which though ranked lower produce more acceptable skilled workers. In spite of this KUST has produced a good number of self employed graduates some of whom own and run their own clinics, pharmacies, hospitals and factories. In the report a few examples of these entrepreneurs are given.

In the area of links with productive sectors and research institutions the university has links with universities in Denmark, India, The Netherlands and the US but not many links with

African universities. Inside Ghana it works very closely with Ashanti Gold, Tema Oil Refinery, VALCO Trust Fund, Unilever Ghana, Standard Bank of Ghana, the Volta River Authority and Vodafone Ghana. These are some of the biggest enterprises in Ghana. The research and innovation activities of KNUST target supporting farmers and designing new sources of energy. It has for example introduced a new variety of high yield, drought and disease resistant cassava with excellent nutritional value and it has popularized it in Ghana working closely with the Ministry of Agriculture. In collaboration with Texas Instruments and Texas A&M University, it has designed the first and only integrated circuit in Sub Sahara Africa North of the Limpopo. In May 2003 it rolled out its first vehicle named ‘Akufo Adamafo’ or ‘farmers’ friend’. This vehicle is made for rough and rocky terrain and has been popular in poor farming communities. Other innovations that have been commercialized in Ghana include a mechanical cassava harvester, a biochar reactor for producing biochar for soil fertilization and a power system that combines solar energy with electrolysis of water to enable storage of excess energy in rural communities.

Jomo Kenyatta University of Agriculture and Technology (JKUAT) also started as a college of agriculture and technology in 1981 and became a university in 1994. It has programmes in mechanical, manufacturing and materials engineering; electrical, electronic and information engineering; civil, environmental and geospatial engineering; architecture and building science; other sciences; human resources development and several special short courses offered to productive sectors and communities. Its major contribution to innovation and support to productive communities include the tissue culture banana project that produces high yield banana seedlings which have been commercialized in East Africa and have increased food security and contributed to poverty reduction. Like the KNUST, the JKUAT has developed a walking tractor which has very low fuel consumption and performs multiple functions such as haulage, traction and tillage. It is very popular in small scale farms. In addition, JKUAT has developed an ECO block making machine which enables small scale block makers to make between 300 and 400 building blocks a day. These machines have been commercialized and are sold to small scale industries at user friendly prices. Other innovations include a low cost fruit pulper, an environmentally friendly shoe polish developed from weeds that were once a menace to farmers and are now sold as raw materials for its production; an assortment of processed food and chemical products most of which are bought and sold by small scale traders and practical courses on food processing, mushroom production, food analysis and ICT use which are regularly offered to youths and have helped to build capacity for self-employment in Kenya.

The Polytechnic of Namibia (PoN), started as Technicon Namibia during the period of colonization by South Africa but in 1994 the Technicon and another institution known as the College of Out of School Training (COST) were merged into PoN. It is very popular among secondary school leavers looking for skills training in order to enter the labour market. It therefore attracts many applications but due to limitations of space, size and scale, it
manages to absorb only about 25% of the potential intake. In 2010 it had over 12,000 students and given the population of Namibia of about 1.8 million, this is a very significant number. It offers courses on business management, ICT, natural resources and tourism, legal studies, engineering, health and applied sciences and human resources development and management.

The National Council of Higher Education in Namibia conducted a tracer study of all graduates in Namibia for the period 199-2008 and found out among other things that most graduates tend to contact at least three employers before getting a job after graduation. It estimated that 15% of the graduates of the PoN get jobs after contacting only one employer but more than 60% undergo on the job training after being recruited which shows a big gap between classroom teaching and the world of work. The study also reported that 70% of the graduates from the PoN are employed by the public sector. This may also show that the skills imparted are more relevant to that sector. According to the report only 1% of the PoN graduates are self-employed. Compared to the University of Namibia (UNAM), more graduates of the PoN were unemployed (14.4% against 11.7% for UNAM) and it is reported in that study that 27% of the PoN graduates said they could not find jobs that were related to their skills while 24% of those employed thought they had bright prospects for their future careers. Some employers felt that graduates in general in Namibia had low communication skills and the majority of them felt that the courses which were offered in tertiary institutions in that country were not very well linked with the demands of the labour market and the world of work.

From the three case studies and the general study on links between universities and industry, the following need to be noted. First tertiary education institutions have a big potential to push the frontiers of science, technology and innovation to higher heights but to do this they need to adopt an innovative systems approach which as explained earlier focuses on making knowledge accessible and getting it used by all actors in the processes of innovation. In that vein researchers and innovators in these institutions need a paradigm shift through which they stop looking at research, science, technology and innovation as ‘academic’, self-serving engagements but as vehicles for the growth and competitiveness of their organizations and the development of Africa’s economies.

Secondly if ‘science’ as taught and practiced in tertiary education institutions has to meet and blend with the technology and innovation in the worlds of production in firms and farms, there have to be convergences between this science and those technologies and innovations. In recent years such convergences have emerged in agricultural research. Traditionally the lead paradigm was for National Agricultural Research Systems (NARS) through which researchers conducted research and innovation activities and through extension or commercialization passed the services and products to other actors especially farmers without getting them involved in the research and innovation processes. This changed with the adoption of the Agricultural Knowledge Information Systems (AKIS) which rather than focusing on extension
support seeks to ‘strengthen linkages and communication between system actors’ including farmers. Noting that even AKIS was not integrating innovations of researchers and those of farmers a new approach was adopted known as Agricultural Innovation Systems (AIS).

Distinguishing the three approaches, Assefa and others\(^3\) have noted that the NARS approach is mainly state driven, top down and bureaucratic. It concentrates on planning for agricultural research, technology development and transfer. On the other hand AKIS focuses on strengthening communication between actors and knowledge and service delivery to rural people. The more advanced Agricultural Innovation Systems (AIS) focuses on strengthening capacities for innovation throughout the agricultural systems as a whole. Therefore AIS does not only support transfer of technology or their products but it enables actors at all levels to be involved in the innovation process. Therefore NARS is guided by the principle of using science to create invention; AKIS is based on the need to provide access to agricultural information and knowledge while AIS is driven by the need to use new knowledge by creating capacity and capabilities for its optimal use for social and economic development.\(^4\)

Our assessment is that the tertiary education institutions studied still depend on the NARS approach. They invent and pass knowledge and technology products to the productive communities without extending the knowledge base to these communities. There is need to change gear to the AKIS and AIS approaches if convergences are to emerge and science and technology to merge.

Finally it is important to note that youth unemployment can be reduced if tertiary education institutions link up with productive sectors in curriculum development and in the so-called ‘open space activities’ identified in chapter 2 of this report. The tracer studies carried out by national authorities in Ghana and Namibia show that the greater the distance between classroom imparted skills and skills required in the worlds of work, the higher the rate of graduate unemployment is likely to be. Some ways of bridging the gaps have been suggested extensively in chapter 2.

**Key Recommendations:**

- Review and renew missions and visions of institutions of tertiary education to give them a sharper focus on science, technology and innovation.
- Increase opportunities and incentives for collaboration between industry and institutions of higher education.

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\(^4\) Ibid. p. 40
• Strengthen the demand orientation of the courses taught and research carried out in the institutions of tertiary education in order to make them more relevant, location specific and embedded in local systems of production.

• Strengthen links by getting industry more involved in curriculum design, evaluation and innovation activities.

• Undertake regular and periodic tracer studies on the absorption of graduates into the labour market in order to help institutions of tertiary education to undertake curriculum adjustments and innovation.
The Role of Higher Education Institutions in Technological Knowledge Creation for Industrial Innovation through Links with Industry

By Prof. Paschal B. Mihyo

2.1 Introduction

In the Lagos Plan of Action 1980-2000 which is the most comprehensive development blueprint in Africa, it is stated categorically that:

‘The industrialization of Africa in general, and of each individual Member State in particular, constitutes a fundamental option in the total range of activities aimed at freeing Africa from underdevelopment and economic dependence. The integrated economic and social development of Africa demands the creation in each Member State, of an industrial base designed to meet the interests of that country and strengthened by complimentary activities at the sub-regional levels.’ [Clause 56: Lagos Plan of Action 1980.]

Research, training and focused policy and interventions related to science and technology were underlined as critical to the transformation of African rural and urban economies to enable the continent to control and gainfully utilize its abundant resources. In Chapter V of the Plan, the development and application of scientific knowledge in all sectors was emphasized. Member States committed themselves to create platforms for:

(i) Exhibiting indigenous technologies;
(ii) Exchange of knowledge among African scientists and technologists;
(iii) Promoting technology transfer among Member States; and
(iv) Promoting technical cooperation among Member States (Clause 122).

Furthermore in the same clause, member States were called upon to develop policies that promote research and development in science and technology; to develop policies that will encourage experts in the Diaspora to return to the continent; to establish centres for science and technology; to formulate national science policies and adequate monitoring mechanisms and to support research to contribute to the development of indigenous technology, scientific human capital and its utilization and technology transfer (Clauses 122 and 123). The mechanisms for technology transfer were spelt out in Clause 123 (iv) to include:

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5 Until February 2012 Prof. Mihyo was Executive Director of the Organization for Social Science Research in Eastern and Southern Africa (OSSREA). After that he will be Director of Higher Education at the Partnership for African Social and Governance Research (PASGR).
‘(iv) the creation of the missing components needed for a comprehensive science and technology system (such as research and development institutions, technological information services; consultancy services; pilot plants and testing grounds, standardization and quality control establishments)’

Chapter V of the Lagos Plan of Action provides the framework on how to promote science, technology and innovation. Ever since the plan was launched, African countries have take measures to implement it, especially Chapter V. They passed the first generation of national science and technology policies and set up national commissions for science and technology. Beginning the year 2000 we have witnessed a wave of second generation science, technology and innovation policies. ‘Innovation’ has been added indicating a paradigm shift from notions of ‘transfer of technology’ from the North to the South, which have not worked, to the need to support the development of local technical and technological capabilities. In addition, regional economic communities and the African Union have launched long term policies aimed at the development and implementation of a science, technology and innovation led development paradigm. Universities in the region responded to the Plan by availing their services to the institutions of science and technology and also to industry in the seventies and eighties, mostly concentrating on informal short term arrangements such as conferences, student attachments and consultancies. Industry also responded by utilizing available human capacity in universities to increase its competitiveness and knowledge base.

From the nineties to date the landscape has changed very rapidly. In addition to embracing the paradigm of innovation as part and parcel of national and regional science and technology policies, governments in the region have adopted policies that seek to support science education and the link between science faculties and productive sectors especially in agriculture and industry. Regional economic communities have designed new strategic plans and policies which aim at fostering collective self reliance through a science, technology and innovation led development paradigm. Universities have been called upon to be more responsive to the technical and technological needs of the continent and they have responded by entering into relations with industry, establishing technology transfer units and offices, technology parks and institutes of production innovation. All these efforts seek to create the missing components needed for a comprehensive science and technology system highlighted in Part V of the LPA. This chapter seeks to assess the extent to which regional policies and interventions have contributed to this effort; the
manner in which institutions of higher education and industry in the region have positioned themselves to play a dynamic role in this effort; the limitations of each in this endeavor and possible ways of overcoming these limitations.

2.2. Regional Policies on Knowledge Creation, Sharing and Utilization

There are four major policies that the African Union has developed that seek to promote the creation of high level capacity in African institutions of higher education and support them to create and share knowledge with productive sectors. These include the 2nd Decade of Education for Africa Plan of Action 2006-2020 which was passed in October 2006; The Performance Indicators for the Second Decade of Education in Africa, passed in October 2008; the AU-NEPAD Consolidated Science and Technology Plan for Africa, 2007 and the AU project on the Establishment of the Pan-African University (2010) which is an on-going project.

The 2nd Decade of Education for Africa Plan of Action aims at strengthening capacity for knowledge production and quality assurance; to promote the contribution of high level knowledge to production and wealth creation and to facilitate inter-organizational cooperation and collaboration at national, regional and continental level. The strategies for attaining these objectives include: promoting knowledge networks; promoting academic staff exchange; fostering high quality publications and supporting the creation of synergies and networking between institutions, agencies, initiatives and programmes at regional and sub-regional levels.

The Performance Indicators for the Second Decade of Education in Africa policy establishes quantitative indicators tied to enrolment, students trained and the proposition of foreign staff in African universities. The qualitative indicators include: the proportion of PhD holders among academic staff; the average number of peer reviewed publications; the amount of funds allocated for research in institutions of higher education (IHE); the average number of consultancies undertaken by IHE; the number of students finding employment after graduation; the number of collaborative agreements signed with other institutions at national, regional and international levels; the number of joint educational programmes delivered with other institutions and the number of staff participating in staff exchange programmes. Some of these indicators are included in the AU-NEPAD Consolidated Science and Technology Plan for Africa.

The AU project on the Establishment of the Pan-African University seeks among other things to develop a world class critical mass of graduates in science, technology,
innovation, human and social sciences; to stimulate collaborative, internationally competitive cutting edge fundamental and development oriented research in areas having a direct bearing on the technical economic and social development in Africa and to promote partnership with public and private sectors, international organizations and the African Diaspora [AU 2010].

Another regional organization that has developed a robust policy on the link between higher education and science, technology and innovation is the African Development Bank (ADB). Through the Higher Education, Science and Technology Policy (ADB 2008) the ADB undertakes to support the creation of skills that enhance competitiveness and sustain growth; to support original approaches to skill development and to foster links between higher education sectors and the private sector and to work with other regional organizations to support national and regional centres of excellence and create conditions for higher education to support other sectors.

On their part, the regional economic communities have further advanced the Lagos Plan of Action by launching focused policies that seek to promote regional investments and export competitiveness through knowledge based systems and interventions. In the Treaty for the East African Community [EAC] 1999, Member States undertake among other things to strengthen research capacity in IHEs, support staff and student mobility; facilitate knowledge sharing; encourage and support the participation of the private sector in the development of human resources through education and training and support centres of excellence. To promote science, technology and innovation the EAC has formed the East African Commission on Science and Technology which will support the development, application and utilization of scientific knowledge. The strategies for this include joint establishment and support for scientific and technological research; the creation of a conducive environment for the promotion of science and technology; the support for exchange of scientific information and personnel and the promotion of publication of research and scientific findings and most important, the harmonization of policies on commercialization of technologies and promotion and protection of intellectual property rights [Weggoro 2011: 10; Treaty for East African Community Article 103].

In the Draft EAC Development Strategy for 2011-2016 it is noted that the previous strategy 2006-2010 achieved a lot in the area of science and technology but the major challenges were lack of a regional science and technology policy; inadequate mechanisms for regional collaboration and networking on research and technology development and innovations [EAC 2011: 35]. To address these challenges, the new EAC Development Strategy for 2011-2016 has identified as its Development Objective No. 6 to strengthen regional competitive
and sustainable productive sectors. Within this objective priority number 2 is to support regional industrial development and technological innovation. The strategies for this include among other interventions, support for SMEs, linking SMEs and MNCs, strengthening regional industrial R&D, technology and innovation systems; the establishment of a regional and financial mechanism for supporting regional industrialization and investments.

Science and technology in SADC falls under the human resources development sector which has developed a Protocol on Education and Training aimed at establishing joint research facilities and equipment sharing; the establishment of regional centres of excellence and free movement of researchers in the region, among other things. The implementation strategies include the collection and sharing of information on science and technology; identification of special areas of focus for basic and applied research and development of regional and international linkages [Weggoro 2011:11].

The development theme for 2010 in COMESA was ‘Harnessing Science and Technology for Development’. At the COMESA Summit on the 30th August 2010 the Heads of State and Government of COMESA committed to establish science parks, an ICT Training and Skills Development Fund and the COMESA Council of Ministers committed their countries to create a joint high level committee on science, technology and innovation; establish or strengthen offices of science, technology and innovation at national level; promote regional academies of science, technology and engineering; establish an Innovation Award for outstanding accomplishments and set up a centre for regional integration. [Weggoro 2011: 11-12]. Other RECs such as ECOWAS have similar policies.

It is within the context of these regional policies that the new generation of science, technology and innovation policies has been developed. But apart from the ADB Higher Education, Science and Technology Policy [ADB 2008] which is backed by a commitment of financial resources aimed at supporting its implementation, the remaining policies are not backed up by such resources. The SADC protocol and EAC Development Strategy 2011-2016, have comprehensive results based matrices indicating resources required for each strategic objective but they do not contain specific pledges on how members will contribute to the required resources. Another element worth noting is that although the ADB HEST policy is emphatic about linking the knowledge systems of the private sector and those of the institutions of higher education mention of the private sector or industry is muted in the policies of EAC, COMESA and SADC and very occasional or casual in the policies of the AU. As we will see later these shortcomings encourage a policy vacuum. In the next few sections we will examine the responses of industry and institutions of higher
education to the need to forge links and create platforms for collaborative creation, sharing and utilization of knowledge through university industry links.


a) The idea of links

The concept of the ‘entrepreneurial university’ that underlies the university-industry links has been a subject of policy and academic debates for the last three decades. The proponents of this concept approach it from various angles. Some think it is the best way of bringing the so-called ivory towers to the needs of the real economy which supports their existence and make them part of the engines of economic growth. Others however look at it from the pragmatic view of convergences between scholarly and commercial orientations of the academic and industrial systems of knowledge [D’Este and Perkin 2010:4]. Opponents of the entrepreneurial university focus only on the negative impact of extra-curricula research and consultancies on the mission and primary objectives of a university. They justifiably express caution that market driven research can easily lead to diversion of universities from pursuit of knowledge to serving corporate interests. In *Scholars in the Market Place: The Dilemmas of Neo-Liberal Reform at Makerere University, 1989-2005*, (Mamdani 2007), Mamdani has used case studies from Makerere to show how unregulated participation in the market through contract teaching and research can easily lead to dilution of curriculum, relegation of core functions of the university to secondary objectives; resource conflicts between departments and between staff in universities and a total ‘juakalification’ of higher education.

In spite of a few bad experiences such as the ones documented about Makerere University, it has become crystal clear in many countries that institutions of higher education do not exist in a vacuum. They are surrounded by various environments that shape and influence their activities and existence and shape their choices. These choices include what roles they can play in their societies. Universities in advanced and even some African countries are surrounded by industrial complexes or farms and production and service centres, most of them searching for knowledge needed to enhance their competence, competitiveness, productivity and efficiency. In advanced countries universities put more emphasis on leading edge science and engineering research. They create and patent knowledge and create mechanisms for its transfer either through licenses, technology incubators, technology parks or other formal and informal channels. The competitive environment in which universities operate creates the push factors not only for innovation and inventions

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6 The term ‘jua kali’ refers to the informal sector in Kenya.
but for collaboration between the industrial and academic sectors of knowledge (Hughes, 2009: 5). Therefore competition, demand and collaboration are very critical in any link between these sectors and the absence of either of them affects that nature and intensity of collaboration.

Another factor linked to competition and demand is the capacity for diffusion. Before the last prophets appeared on the scene, there were many before them. Their messages were perceived but not received not because they were false but because the societies they lived in had no capacity to absorb and diffuse those messages. Without the capacity of industry to absorb, diffuse and translate knowledge into products and services, there cannot be effective demand for research in general and university industry links in particular. This may explain why agricultural universities and research institutes in Africa have not had a big impact on the agricultural and livestock technology in communities surrounding them.

Policy support is also critical for these links. In countries where universities are viewed as part of the local or national structures or institutions of development, they are factored into local and national industrial and technology development plans. More often than not, such universities adjust their curricula and research orientation and programmes, to respond to policy changes or adjustments in investment patterns. When industries re-locate, such universities make efforts to establish a presence in their new places of operation. When industries restructure, curriculum is changed to adjust to the new needs of industry. These measures sustain the demand orientation of knowledge based in the universities and the demand supports increased need for collaboration.

It is therefore a defendable proposition that where universities are viewed by policy makers and the productive communities as partners in local and national development, they will position themselves strategically to be part of local and national development actors. Policy sectors will give them all the support they need to play that role through adequate funding, procurement procedures and regulatory frameworks that reduce bureaucratic red tape and excessive financial responsibilities in terms of taxes etc. On the other hand if universities are viewed as mere institutions of learning or as centre of youth development, they cannot develop the necessary dynamics to enable them play a developmental role in areas of knowledge creation for technical and technological development.

It follows from the above proposition that universities that are conscious of the changing needs of society especially within the contexts of the new, and now not so new, development visions in Africa can undertake their own assessment of the gaps that exist in the sectors relevant to their various missions and the goals of these development visions.
There is no record to show that any university in the region has undertaken the exercise to review their national visions, identifying niches that they think are feasible for collaborative research and technical assistance to industry and other productive sectors. If this was done, policy makers would be advised on how to use university industry links to bridge gaps between development objectives and objective realities.

2.4. Forms of University-Industry Collaboration Links

Whenever links between academic and industry knowledge sectors are raised there is always the temptation to think big. Because the concept of ‘technology’ creeps into the imagination, it is conceived as revolving around machines and equipment, patents and licenses etc. This high level interpretation of technology which is tied to hardware, blue prints and intellectual property misses out the other critical elements of technology which revolve around technical and technological capabilities. Autio Laamanch (1995) as quoted by Ankrah (2007: 4) has extended the definition of technology to include:

‘the ability to recognize technical problems, the ability to develop new concepts and tangible solutions to technical problems, the concepts and tangibles developed to solve technical problems and the ability to exploit the concepts and tangibles in an effective way’.

If technology is viewed as broadly as to include ability and capability to create and use knowledge, then knowledge creation and utilization should not be confined to intellectual property and its commercialization. There are numerous modalities through which universities and industry collaborate for knowledge creation and utilization. There are formal and informal modalities.

Alan Hughes (2007: 5) has identified four ordinary modalities of university industry links. They include training either through regular courses or through special courses which produce adequately qualified human capital for industry; basic research which becomes accessible without any transaction to society; problem solving which can be through technical assistance or advisory services aimed at addressing the specific needs of businesses and what he has termed the ‘public space functions of universities’. These include conferences, meetings, entrepreneurship promotion centres, staff exchanges between universities and industry and internships. These public space functions facilitate knowledge acquisition and sharing and lead to effective transfer of knowledge between the
two sectors. Other informal links as identified by Bassant and Chandra (2005) based on experiences from India include labour related links through which universities train for existing skills and respond to emerging needs by designing new courses and programmes; commodity and service response links for testing, certification, prototype development, trouble shooting; and project links for creative acquisition and dissemination of knowledge through various mechanisms. Informal ones tend to be either short term or between organizations and individuals in universities. These have been in existence since the beginning of universities.

Formal links however tend to be inter-organizational, more structured and technology development oriented. Constraints of funding within universities and the decline of public capacity to support all their needs have created demand for alternative sources of funding. Contract research has become one of the biggest sources of funding in this direction (Schiller and Diez 2007: 38). On the part of industry, the changing nature of knowledge has called for acquisition of knowledge from other sources outside the enterprises. Rapid technological change and increasing competition in the production and sale of services and goods has led industries to move further than informal mechanisms of knowledge acquisition into outsourcing research and development activities to other knowledge sectors especially universities.

In what has been termed ‘Mode 2 Knowledge’ there have been convergences between research disciplines at university level and research activities at university and industry levels. The driving force is competition and the challenge is the increasing complexity of products and services whose development requires skills and expertise from more than one organization or discipline. The interface between activities and actors has led to coalitions between universities, industries and governments in what has come to be popularly known as the ‘Triple Helix’ [Etzkowitz and Leydesdorf 2002; D’Este and Perkman 2010]. The ‘Triple Helix’ concept reflects a tripod of scientific knowledge creation and utilization characterized by the establishment of institutions such as the technology transfer offices, institutes of production innovation, research and innovation clusters that target specific industries, science parks and technology incubators. Such institutions are formal and seek to establish long-term links with industry. Governments become actors by supporting the establishment and running of such institutions.

Universities globally especially in the natural sciences have embraced the ethos of academic entrepreneurship which these institutions promote. They have developed strategies for increasing their capacity to generate, share, disseminate and transfer their knowledge generated through research. The modalities of university industry links which
are formalized involve joint ventures, research networks, consortia, alliances, trade associations and as aforementioned, technology parks, patent and licensing arrangements, sponsored or contract research. Other modalities include long term agreements for staff exchange, grants to support specific research themes; support for publication and dissemination by sponsoring journals dedicated to science, technology and innovation and support for sabbaticals. (Ankrah 2007: 11). To this list Sentoro (2000) has added endowments or trusts; cooperative research; cooperative education for knowledge transfer for product development and commercialization etc. via research centres in Universities.

The key words in these formal links are ‘inter-organizational relationships’. Unlike informal links which are based on working through individuals, formal links are institutional. As we will see soon, in the areas of technology and innovation African Universities are stronger on informal rather than formal links.

2.5. Some Selected Experiences of University-Industry Links in Africa

In this section it is argued that inter-organizational relationships between universities and industry in Africa are still weak, loose and predominantly informal. Even where universities have established networks or institutes of production innovation, technology centres or even incubators, they do not have organic links with enterprises. These centres remain embedded in the traditional structure of the universities and occasionally interact and transact with their clients. Even where the universities are directly involved rather than through their individual staff, the modality is still that of consultancy. However when it comes the public space functions mentioned by Hughes (op.cit) African universities are very active. In the next sections we look at examples of this.

2.6. South African Universities in the Public Space Functions

South African universities have for a long time worked closely with industries. Some of them such as the University of Stellenbosch are very strong on engineering research and work closely with British Aerospace and NASA in addition to local enterprises. The majority link up with industry through what Hughes has termed public space functions. Similarly enterprises have for long influenced activities of universities. Pretorius [1993] has documented various modalities through which industry participates in activities of universities and other educational institutions. The general links are through students. Using field visits or attachment to industries, students learn about real life situations of work. In some cases universities enter into arrangements through which experts form industry visit universities and offer career guidance to students both about their careers
and the professional world of work. Through career guidance experts from industry visit universities and give practical training on interviews, work experiences and career paths. It is also usual for industry to offer places to universities to second staff to enable them to learn new techniques especially in the physical sciences.

Staff exchanges and joint course development is also common. According to Egglestone 1987 and Pretorius (1993) industries have been influencing curriculum in universities through five interventions. First, by ‘infusion’ through which, they provide additional activities to universities that stimulate changes in curriculum in order to adjust to changes in the environment. Second by providing work experience opportunities to staff during sabbatical leave, for them to get exposed to new ways of doing things. Third is job creation. Through this industries provide resources for some research activity, allow universities to hire graduate students to undertake research and use the results either to create new products or services and to absorb the students into its labour force. The fourth is link courses. More often than not, courses offered by universities do not necessarily meet the expectations and needs of industry. To bridge the gap industry and universities enter into arrangements through which extra-curriculum training is offered to bridge the gap between the classroom and work situations. This is more pronounced in the physical sciences. Students are taken to industries for on-job training. The fifth modality is work simulation through which students are given opportunity to acquire knowledge, insights and experience while still learning. Small projects are set up either at university or in a technology park and students are taught how to design products and market them.

The second category of public space initiatives relates to corporate programmes. These are more pronounced in commerce and management. According to Weinner (1988) and Pretorius (1993), these are more formal than informal. They include purchase of courses. Banks or factories either sponsor the development of a course or modules in a course or offer to provide fellowships for an existing course in which it is interested. A second modality in this channel is where an industry purchases curriculum development projects and by doing this avails itself of the opportunity to shape curriculum in areas of its interest. The Third modality is establishment of joint projects to develop courses and curriculum. This is more frequent in engineering faculties. By taking joint responsibility for curriculum, universities and industry shape the knowledge systems in the two sectors together. Out of these links bigger collaboration arrangements begin to emerge. They include contract research, reciprocal exchanges of staff on sabbatical leave; adjunct staff from industry teaching in universities; part-time, half time or zero – attachment of
university staff to industry; joint bidding for external projects; joint consultancies; joint research and interlocking membership on committees and boards.

The fourth category of links relates to industry support for teaching and research in universities. Once university public space initiatives begin to tick, they attract industry’s interest in supporting teaching, research and outreach. Industry gives support through donations to core funds; donation of equipment; sponsorship of conferences and seminars; support for raffles; advertisements; competitions and company awards to staff and students. It is important to note that although it is easier to measure the impact of such links through measurable outputs such as patents, licenses and spin-off companies, it is not easy to measure the impact of such modalities of collaboration. However, even in developed countries, public space collaboration accounts for the biggest proportion of university-industry linkages [D'Este and Perkman 2010].

2.7. The Innovation Systems and Clusters Programme in Eastern Africa [ISCP-EEA]

In 2003 the College of Engineering and Technology at the University of Dar Es Salaam initiated the formation of the Innovation Systems and Clusters’ Programme in Eastern Africa. The objective of this network is to fast track socio-economic development in Eastern and Southern Africa; to create awareness and appreciation by industry, policy bodies and the public on the need for and effectiveness of innovation systems; to promote awareness of the importance of competitiveness and to foster learning from best practices on the development of innovation systems. By the end of 2010 the project included all the five countries of the East African Community [Burundi, Kenya, Rwanda, Tanzania and Uganda] and Mozambique and Zimbabwe in Southern Africa. The project is supported by Sida (Sweden) and the World Bank. It works closely with other innovation networks such as VINNOVA in Sweden which is devoted to supporting research for effective innovation systems in Sweden. The project aims at small and medium enterprises.

In Tanzania the network has used five methods of working with small enterprises. These include research and policy reviews on innovation systems; implementation of pilot innovation systems and cluster initiatives; awareness creation and publications; competence building and mobilization of support for innovation systems.

At the end of 2008 the network had launched eight pilot initiatives in Tanzania which include:
• The Bagamoyo Cultural Heritage Tourism cluster – an architectural and engineering initiative to upgrade Bagamoyo town as a tourism centre.

• Eastern region mushroom cluster initiative – a project to promote the production and export of mushrooms from Tanzania

• The Morogoro metal-works cluster – an initiative to promote iron smelting and the manufacture of farm implements

• The Morogoro small scale fruit and vegetables processors cluster – transfer of solar drying and preservation techniques to small scale vegetable processors.

• The Arusha vegetable seeds cluster.

• The Tanga / Korogwe sisal cluster – research on new uses of sisal fibre

• The Zanzibar sea weeds cluster and

• The Dar Es Salaam nutraceuticals /functional foods cluster

The Uganda chapter of the network based at Makerere University has also established seven cluster initiatives covering [Turyagenda 2006: 155-166]:

• Pineapple juice processing

• Fashion and textiles

• Metal fabrication

• Basketry

• Ethanol and biofuel

• Lake Katwe Salt and

• Management Consultancy

In spite of the enthusiasm generated by the project, the project leaders feel that the SMEs in the region were still under-performing even within the project because, according to the Tanzania Chapter coordinator, most of them use obsolete technology and under-performing machines; the majority cannot raise loans for lack of collateral, they are poorly managed and unable to access markets; infrastructure is inadequate; they have no capacity for networking and they have very high production costs [Mshoro 2006: 48]. In Uganda the report from the Kayunga Pineapple Cluster Initiative listed a long list of obstacles to growth and success (Muyanja and Turyagyenda 2006: 188-198] hinging upon lack of infrastructure; poor equipment; low competence and skills; poor materials, limited markets and low products’ quality; unpredictable weather and prices and high cost of loans, certification and quality control services; and lack of information and extension support.
All the clusters initiatives are based on the triple helix concept which is the tripod for knowledge creation, sharing and utilization. In the ISCP-EA project this concept is more pronounced in the Sisal Cluster Initiative in Tanzania. In its strategy the initiative spells out the agro-industrial sector which is private, the government targeting five ministries and the academia as the main actors. In the academia group six disciplinary segments are targeted i.e.: chemical and process engineering; materials technology; applied microbiology; food science; agricultural technology and biotechnology [Masanja 2006: 261-275].

In all the ISCP-EA cluster initiatives the links with industry do not as yet have any outputs that can be patented and commercialized. Market analysis for the existing and intended products has not been thoroughly carried out. There is very little collaboration between small firms in the project and established R&D institutes in the relevant sectors. Technical and technological capabilities within the partner SMEs are very low and as a result there are no catchment conditions for technology learning or transfer and information on what is done by SMEs in other countries or regions in the same areas of specialization is not readily available. Finally and most important, large scale enterprises in Uganda and Tanzania have not been attracted to the project. At the same time even within the universities involved not all senior and reputed researchers are involved in the cluster project. In the next section we examine what factors that motivate or inhibit enterprises from entering into links with universities and what factors reduce the interest of researchers to these links.

2.8. Barriers to University-Industry Links

There are three clusters of barriers to these links. The first relates to policies; the second to the universities and the third to industry. It is important to note that academic institutions are under increasing pressure to raise the so-called third stream funds in addition to capital development and institutional support funds they get from their sponsors. This pressure has translated itself into a frantic search for research contracts, cost-sharing, user-fees and donations. Studies from the region indicate that cost sharing and students loans have reduced the burden of financing some teaching costs for universities but cannot fill the gap in institutional support budget caused by reduction in government funding [Johnstone 2004], Woodhall 2004, Otieno 2004 and Ishengoma 2004). In addition, several income generation activities (such as commercialization of facilities, consultancy bureaus and investments in real property which have been launched since the 1990s) have had no significant impact on university finances [Kiamba 2004; Butera 2004; Musisi and Muwanga 2003; Aina 2003; Babalola et.al 2003]. Similarly small informal
activities in the public space contribute by topping up incomes of underpaid staff but cannot substantially transform the financial situation of African universities. The ultimate solution lies in robust formal links aimed at leading edge research which can lead to inventions, innovation and generally the creation of applicable knowledge. However there are several barriers to this on the part of all actors: researchers and universities; enterprises and government.

2.9. Reservations on the part of universities

Universities in Africa have been pressurized into searching for alternative sources of funding. It is not in their mission statements or mandate to engage in academic entrepreneurship. Most of the laws establishing public universities cater for teaching, research and community engagement. The interpretation of ‘community engagement’ has left enough room for universities to engage in academic entrepreneurship. But for some university leaders, community engagement simply means producing knowledge relevant to society and not necessarily marketing or commercializing it. Some university leaders who share the view of D’Este and Perkins (2010: 8] that if universities get involved too much in research agendas of industry and try to go for commercialization they stand the danger of becoming ‘knowledge businesses’, do not support large scale projects that can easily turn university teaching into a part time activity.

The second limitation for universities is that leaning too much toward academic entrepreneurship entails the risk of abandoning basic research and concentrating on applied research because it carries immediate financial gains. For some this may amount to abandoning the traditional role of universities – the search for knowledge. Beneath this fear is the issue of relevance. Contract research in the natural sciences is usually funded by multinational corporations. Their research agendas are not necessarily linked with local or regional agendas. The predominance of multinationals in the contract research and consultancy market carries the potential of gravitating research in the universities from national research priorities.

The third reservation among universities is emanates from cost. Although no cost-benefit has been carried out, it is clear that university-industry links cost universities a lot. Maintaining institutes of production innovation, technology centres or technology parks is very costly. Universities spend lots of resources some of which are taken from limited institutional funds allocated to core functions such as staff development, teaching and research. The rates of return on such investments tend to be low given the scale of activities related to the links and their financial contribution to university resources.
2.10. Reservations on the part of researchers

Analyzing the motives underlying the participation of academics in university-industry links D’Este and Perkins (2010) have noted that following. First universities are autonomous organizations that allow academic staff to search for activities that complement teaching. They have flexible working schedules and benefit sharing schemes that enable them and their staff to gain from partnership in research with other organizations. They noted however that while monetary gains are a motivating factor for researchers, most of them are further motivated by access to industry and its facilities, building a reputation among peers in industry academia and publishing. They made a few pertinent conclusions about what motivates academics to participate in the links. Their first conclusion is that university researchers target projects that will strengthen their standing in the academic community and which are directly related to their research interest. Secondly that for the majority of them patents and licenses or the commercialization of knowledge is the least motivating factor. Based on their interviews with German researchers they concluded also that working with industry is not primarily motivated by monetary gains.

The application of these conclusions to the African situation may be difficult because contrary to the position of academics in Europe, one of the observations on the African continent is that African academics are more motivated by monetary gains because of poor compensations systems within universities. But this has a limit. In Botswana and Namibia as well as in some universities in South Africa, many senior researchers prefer to do research within their research interests, at universities and using available university resources. It would follow therefore that where academics are adequately compensated and supported by their universities to do in-house research, they prefer to confine themselves to their research projects and do not get involved with industry.

Furthermore, D’Este and Perkin noted from their research that senior researchers approach university-industry links with more caution that junior researchers. The former prefer areas of research closer to their interests while the latter view these links as platforms for visibility, access to knowledge, equipment and materials. The common factor between senior and young researchers is that they value academic freedom and for senior researchers this gives them choice as to whether to get more involved with industry or not while such choice is limited for young or junior researchers. However the fact that research findings arising out of these links cannot be published at all or without the permission of funders becomes a big problem for researchers at all levels because
academic research output is measured through publications for purposes of recognition, rewards or advancement.

The study by D’Este and Perkin covering researchers in Europe and the US produced very interesting results about what motivates researchers to participate in university-industry links. Between 70% and 74% of their respondents said they were motivated by the possibility of their findings being applied. Between 45% and 67% were motivated by the desire to get information on problems of industry and be part of finding solution for these problems. Between 22% and 41% were motivated by access to materials, equipment, research expertise and networking with researchers in industry. Only 16% were motivated by monetary gains and a small proportion i.e.11% were motivated by the possibility to generate intellectual property rights and commercialize them.

Therefore they concluded that learning was the primary motive; access to materials, equipment and data was the second most important. Access to funding was third and commercialization was last. If these conclusions are valid for most researchers including those in Africa then it is possible that the interests of researchers and those of industry are not the same. Industry would prefer knowledge creation and commercialization and intellectual property rights to be the primary outcomes while funding and access should be the means rather than the end. Whether this conflict of expectations affects the intensity of collaboration between universities and industry in Africa is an issue for further research.

While the issue of motivation related to individuals and such conclusions should not be generalized, there are institutional issues that need to be addressed by universities in relation to researchers. First is the capability gap. In order for industry to contract universities for research or even specialized courses the latter should possess better skills than those available in the relevant industries. In some enterprises the level of research and application skills is higher than in the universities. Small enterprises seem to have bigger needs for support from universities but they do not engage in R&D at all or partnership with them cannot lead to cutting edge technology. The fact that most universities are more active in outreach to SMEs and have limited contact and collaboration with large scale enterprises may be symptomatic of a capability deficit that need to be addressed.

The second area of weakness arises from the credibility gap. Scheiller and Diez (2007) carried out a study of universities in Thailand and found out that many universities have rigid recruitment systems and human resources procedures which were bureaucratic and did not allow flexible deployment of staff across research, teaching and technical
assistance. These procedures made lecturers fear that if they entered into contracts with industry they would not be able to meet deadlines of standards of quality. On the other hand they found out that some enterprises were worried that some universities had limited control over staff; that there were no mechanisms to compel them to finish assignments on time. These two extremes exist in African universities. In some of them there is so much autonomy for individuals that there is no control over staff time or the quality of outputs arising from collaborative activities while in others there is so much control that researchers would not be trusted to deliver on time or at all.

Third is the information gap. Not many companies know about the research outputs or activities of various departments in the majority of universities. Very few of them such as University of Khartoum post abstracts of staff and graduate students research output on their website. Fewer post biographies of their staff on their websites. Annual reports in many cases do not indicate research profiles of departments or research output of staff. Similarly very few universities have a comprehensive view of the needs and activities of industries in their locality, country or region. This information gap limits the potential for university-industry links.

Fourth is the conflict between the private and public domains of knowledge. For academicians knowledge is a public good which should be disseminated widely and easily accessed. The publicity increases recognition for researchers and the relevance of universities to society. For industry knowledge is a private commodity which as Brunell, D'Este and Salter [2003] put it ‘should be appropriated for private gain’. This conflict of perceptions also extends to issues of intellectual property rights. At university level, academics feel they have the right to own the intellectual property rights arising out of their research. On the other hand universities feel they should own these rights even if they have not funded the research. This has been a source of contestation. Academics do not see why a donor should fund, the researcher invents and the university owns the rights. In the background is the conflict between universities and industry over these rights. Fear of disclosure by academics or university staff makes industry careful about going into commercialization arrangements with universities.

Furthermore there are policy gaps that need to be addressed. At national level, most policies dealing with science, technology and innovation mention university-industry links but do not give guidelines on funding modalities, support systems or quality assurance. Within these policies funding for universities is not covered and support for R&D in industries through tax and other incentives are missing. In order for universities to transfer or share knowledge with industry, the latter should have R&D activities and
researchers of its own. As Schiller and Diez [2008: 38] have cautioned, using universities as ‘vicarious research institutions’ cannot lead to sustainable development. But industry needs to be supported to develop research capacity and engage in R&D.

Funding constraints are an obstacle to these links. Even in the most endowed universities in the Southern and Northern cones of Africa, universities have funding constraints as a result of which they cannot stretch their capacity to undertake core functions and at the same time support industry for innovation. In addition, innovation though benefiting industry more, increases competitiveness and national revenues. Therefore funding R&D should not be left to enterprises alone. Procurement and tax incentives should be included in national policies on STI.

Most technology development initiatives and networks such as the innovation clusters project are very dependent on donor funding. The funding from universities is not enough to enable them to commit full time staff resources and equipment to innovation projects. It would help universities if governments and industry increased core support for these centres or projects.

Between universities and national commissions for science, technology and innovation there is a big distance even in countries where they are within the same ministry. Narrowing the gap between them can also narrow the gap between science which lies with universities and technology and innovation which lie with the commissions and industry. Furthermore it is important to assess the political distance between universities and governments. Where the two are too close joint decisions tend to be made on choices of areas to do research upon, the enterprises to collaborate with and what sectors to focus upon. Where such decisions are not related to specific projects that are funded by governments, the possibility of governments discouraging universities from participating in links which are not of interest to them is very high. Within the competitive political and social dispensations in African countries the longer the political distance between universities the wider the choice universities will have in areas of research and university-industry links.

2.11. Crossing the barriers – Observations and recommendations

In winding up this discussion, it is important to identify what helps university-industry links to work and remain sustainable. Oliver (1990) as cited by Ankrah (2007) has identified five contingencies that make these links tick and work. They include necessity, asymmetry, reciprocity, efficiency, stability and legitimacy. Whether we are ready or not,
the processes of globalization are pushing the frontiers of competition closer home than before. Even if we are going to de-industrialize and increasingly become a continent of shopkeepers and importers, there's a lot of growth in the area of services. *Necessity* will push all actors to look for competitive advantage and industry will need new knowledge. This knowledge cannot be generated within industry alone. Synergies with universities, think tanks and consulting firms are inevitable. These partners on the other hand are facing funding, knowledge and resource constraints and industry has the resources that they need if they can prove that they have the capacity and the quality that industries can rely upon.

In order for links to work there's need for mutual *trust*, mutual *respect*, *recognition* and *reciprocity*. Universities need to earn these four elements by sharpening capabilities, increasing reliability and predictability; improving depth and quality of research outputs and re-designing curricula to make it stronger on demand orientation and problem focused. On the other hand industry has to win the recognition and respect of governments and universities. An industry which has no R&D, research programme, equipment, materials or data and information will attract researchers with difficulty, will not attract incentives from governments or partnerships in technology development from outside firms.

*Efficacy* and *efficiency* are shaped by time and cost. If research processes take long to produce results at a very high cost, contracts are not renewed and links take a short duration. Links normally start with informal activities and mature into longer term engagements. To manage this transition universities have adopt strategic interventions that can enhance their efficiency. Delivery on time, prioritization of projects, managing costs effectively and improving their credibility can enable them to get longer term contracts.

*Stability* is crucial in any relationship. Staff retention problems within universities are undermining their credibility in these links. Universities need to develop human resources strategies that can provide basis for assurance that once a project is launched the same team will see it through to the end. Long term formal links are possible only with universities in which research capacity is not only available and strong but stable and reliable and where leadership succession is assured.

*Legality* and *legitimacy* deficits can weaken collaboration. The contested terrain of intellectual property rights within universities (academics and their employers) and between them and industry, need to be resolved through contract systems that
accommodate the conflict of interests between actors. At the same time it is crucial to accept that academics value recognition and for the majority of them, presentation of findings at prestigious conferences is more motivating than other gains. Their legitimate right to publish and disseminate needs more space in collaboration arrangements than is currently the case. In addition issues of inequity related to situation where the donor or industry funds the research, the researcher creates knowledge and the university or the industry exclusively own the intellectual property rights, need to be reviewed and redressed.

Finally for the Triple Helix approach to work, governments need to include university-industry links in all their policies on science, technology and innovation and provide for funding, preferential treatment in procurement and various incentives to enable them to work. Industry has to develop its own research capacity, develop long term strategic research and development programmes; help universities generally to train a new generation of technical and technological experts and build strong links with universities to enhance innovation for competitiveness. Universities need to reinvent their curricula to reflect problems in the real economy; to upgrade the capacity of their researchers to give them a competitive edge over researchers in other sectors; to take all measures to build credibility and trust and to get the right managers for centres of technology and innovation. These should be researchers with a proven record and a commitment to collaboration between universities and industry. These small measures will go a long way in strengthening these links and taking universities a step higher than simply supporting small and medium enterprises.

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CHAPTER 3

Developing and Promoting Technical and Technological Capacity for Employment Creation in Ghana: A Case Study of the Kwame Nkrumah University of Science and Technology (KNUST):

By: Prof Abeeku Brew-Hammond (in partnership with Julius Ahiekpor, Edward Antwi and Edem Bensah)

3 Introduction
This chapter discusses the profile of Kwame Nkrumah University of Science of Technology (KNUST), its mandate, and the number of students it has enrolled and graduated during the past ten years. It examines the employment opportunities for the graduates of KNUST and also highlights the strategic plans of KNUST and the various courses offered, as well as the development activities undertaken by some Departments of KNUST and their relevance to national scientific and technological needs and policies.

The purpose of the project was to study capacity development initiatives in various teaching and research Departments and Institutes that have devoted efforts to skill formation for science and technology at KNUST. In this context, the study focused on the issues below:

- The profile of the institution, its mandate and short history;
- Its strategic plans over the years since its inception and how they have changed over the years;
- Its target clients and how these are reflected in its instruments;
- The number of students and courses offered over a period of ten years;
- The relevance of the courses to the national needs for scientific and technological development;
- The research and technology development activities undertaken by the institution and their relevance to national scientific and technological needs and policies;
- Evidence-based links between the institution and productive and service sectors;
- The institutions that employ the graduates of the courses given and evidence of self employment;
- Links with other tertiary institutions in the country and abroad; and
- A general assessment of the institution and its place in the national development vision regarding science and technology.
3.1. Methodology
The study was mainly done through the review of relevant literature. The team collected background information about Kwame Nkrumah University of Science and Technology by making use of annual reports, curricula of Departments, evaluation reports, strategic plans, newsletters, and web portals. Interviews and discussions with staff were also used to collect data on the research and developmental activities in some selected Departments.

3.2. Profile of KNUST

The Kwame Nkrumah University of Science and Technology (KNUST) began formal operations in 1952, with 200 Teacher Training Students. KNUST has two campuses, one in Kumasi and the other in Sunyani. The main university campus is situated about eight kilometers away from the centre of Kumasi, the Ashanti Regional capital, and covers an area of about 18 square kilometers of undulating land. The University started awarding its degrees in June 1964 (Facts and Figures, 2011). Initially, examiners marked all degree examinations externally after they had been assessed by internal examiners of the University. Currently, internal and external examiners examine all degree programmes. In addition, some programmes are reviewed by external moderators to ensure that high academic standards are maintained.

The collegiate system introduced in KNUST in 2004 made way for the restructuring of the University into six academic colleges to introduce efficiency into the administration of the university. Colleges are semi-autonomous to some extent and could handle issues concerning the colleges internally. The six colleges are:

- College of Agriculture & Resources;
- College of Architecture & Planning;
- College of Arts & Social Sciences;
- College of Engineering;
- College of Health Sciences; and
- College of Science.

The Colleges are composed of Faculties which are subdivided into Departments. The Departments coordinate and collaborate where necessary.

With a modest student population of 915 in 1963/64 academic year, the total student population for the university in 2011 stood at 28,949. This comprises 23,745 undergraduate students and 5,219 graduate students for the 2010/11 academic year. The population also consists of 21,046 males (72.7%) and 7,903 (27.3%) females. The staff strength of KNUST is 3,276 comprising 870 senior members, 851 senior staff and 1,555 junior staff. There are six halls of residence and five hostels in the University. The six halls of residence could accommodate only 7,256 (32.1%) of the total number of registered students. The University also has a number of facilities for use by the university staff and the general public. These
include a hospital, basic schools, maintenance and estate organization, transport department, printing press, bookshop, senior staff club, sports arena, an Olympic size swimming pool, commercial and banking facilities, post office, places of worship and guest houses.

Within the short period of its existence, KNUST has become an important centre for the training of scientists and technologists from Ghana, Africa, and beyond thanks to its crop of experience and highly motivated staff and as well as the availability of ultra modern science and engineering laboratories.

3.3. Vision and Mission Statement of KNUST

a) Vision
The vision of KNUST is to advance knowledge in science and technology for sustainable development in Africa.

b) Mission
KNUST provides an environment for teaching, research and entrepreneurship training in science and technology for industrial and socio-economic development of Ghana, Africa and other nations. KNUST also offers services to the community. It is open to all people and positions itself to attract scholars, industrialists and entrepreneurs from Africa and the international community.

c) Core Values
KNUST is committed to attracting and developing excellent staff and students to achieve the challenging goals, targets and directions the government has set for higher education. The following cherished values characterize the work and life of the University and are ingrained in all those who pass through the University. The following core values are adhered to:

- Leadership in innovation and technology;
- Culture of excellence;
- Diversity and equal opportunity for all; and
- Integrity and stewardship of resources.

3.3. Administrative structure

The University Council, as the governing body, constitutes the apex of a hierarchical structure of a system of committees for the management of the University. The principal officers of the University are the Chancellors, the Chairman of the University Council and the Vice-Chancellor. The Vice-Chancellor is the academic and administrative head of the University and the Chief disciplinary office. The Pro Vice-Chancellor, Registrar, Finance Officer, University Librarian, Director of Works and Physical Development, Director of Health Services, Internal Auditor, Provost of Colleges, Dean of Graduate Studies, Dean of Students, and Dean of International
Programmes report directly to the Vice-Chancellor. The Deans of Faculties report to the provosts of the Colleges whereas the Heads of Departments report to the Deans of Faculties. There is an Academic Board that formulates and carries out the academic policies of the University and regulates and approves the programmes of study and examinations held in the University.

3.4. Current basic statistics

For the 2010/2011 academic year, 28,178 applications were received but only 13,940 could be admitted mainly due to the limited academic facilities. The total student population for the university currently stands at 28,949 (Basic Statistics, 2011). This comprises 23,745 undergraduate students and 5,219 graduate students for the 2010/11 academic year. The population also consist of 21,046 males (72.7%) and 7,903 (27.3%) females. International students’ population stands at 1035 with distribution for males and females being 610 and 425 respectively. The nationality of the international students is distributed over 32 countries. The staff strength of KNUST is 3,276 comprising 870 senior members, 851 senior staff and 1,555 junior staff.

a) Faculty and Staff

The main functions of KNUST Faculty are to teach and mentor undergraduate and graduate students and engage in research. Aside this, some also serve as consultants to local organizations, multinational bodies and industries. The University’s total staff distribution is shown in the table below:

Table 1: Faculty and Staff distribution for 2010/11 academic year

<table>
<thead>
<tr>
<th>Teaching Staff</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Professors</td>
<td>27</td>
</tr>
<tr>
<td>Associate Professors</td>
<td>49</td>
</tr>
<tr>
<td>Senior Lecturers</td>
<td>158</td>
</tr>
<tr>
<td>Senior Research Fellows</td>
<td>6</td>
</tr>
<tr>
<td>Visiting Senior Lecturer</td>
<td>1</td>
</tr>
<tr>
<td>Visiting Lecturer</td>
<td>1</td>
</tr>
<tr>
<td>Lecturers</td>
<td>426</td>
</tr>
<tr>
<td>Research Fellows</td>
<td>19</td>
</tr>
<tr>
<td>Assistant Lecturers</td>
<td>18</td>
</tr>
<tr>
<td>Technical Instructors</td>
<td>19</td>
</tr>
<tr>
<td>Library</td>
<td>18</td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td><strong>742</strong></td>
</tr>
</tbody>
</table>

Non Teaching Staff
**Senior members (Administrative and Professional Staff)** 128
Senior Staff 851
Junior Staff 1555
**Grand Total** 3276

**Source:** Quality Assurance and Planning Unit, 2011

b) **Number of students—Enrolment from 2000 to 2010**
The University has produced about 42,351 graduates between the 2000 and 2011. Table 2 shows the trend of enrolment and graduate output for the year under review.

**Table 2: Enrolment and Graduate output from 2000 to 2010**

<table>
<thead>
<tr>
<th>Year</th>
<th>Enrolment</th>
<th>Graduate Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000/01</td>
<td>10333</td>
<td>1863</td>
</tr>
<tr>
<td>2001/02</td>
<td>11714</td>
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3.5. **History of KNUST**

The Kwame Nkrumah University of Science and Technology (KNUST) started as the Kumasi College of Technology by a Government Ordinance on 6th October, 1951. It was however, opened officially on 22nd January, 1952 with 200 Teacher Training students transferred from Achimota Secondary School, to form the nucleus of the new College. In October, 1952, the School of Engineering and the Department of Commerce were established and the first students were admitted. From 1952 to 1955, the School of Engineering prepared students for professional qualifications only. In 1955, the School embarked on courses leading to the University of London Bachelor of Engineering External Degree Examinations.

A Pharmacy Department was established in January, 1953, with the transfer of the former School of Pharmacy from Korle-Bu Hospital, Accra, to the College. The Department ran a two-
year comprehensive course in Pharmacy leading to the award of the Pharmacy Board Certificate. A Department of Agriculture was opened in the same year to provide a number of ad hoc courses of varying duration, from a few terms to three years, for the Ministry of Agriculture. A Department of General Studies was also instituted to prepare students for the Higher School Certificate Examinations in both Science and Arts subjects and to give instruction in such subjects as were requested by the other departments.

Once established, the College began to grow and in 1957, the School of Architecture, Town Planning and Building was inaugurated and its first students were admitted in January, 1958, for professional courses in Architecture, Town Planning and Building. As the College developed, a decision was taken to make it a science and technology oriented institution. To this effect, the Teacher Training College, with the exclusion of the Art School, was transferred in January 1958 to the Winneba Training College and the Commerce Department was relocated to Achimota College, to form the present University of Ghana Business School, Legon.

In December 1960, the Government of Ghana appointed a University Commission to advise it on “the Future of the University Education in Ghana, in connection with the proposal to transform the University College of Education and the Kumasi College of Technology into an independent University of Ghana.” Based on advice received in 1961, the Government decided to establish two independent universities, one in Kumasi and the other at Legon, Accra. Consequently, the Kumasi College of Technology was converted into a full-fledged University by an Act of Parliament on 22nd August, 1961. The Kwame Nkrumah University of Science and Technology was formally inaugurated on Wednesday, 29th November, 1961.

Since its accession to a University status till present, the KNUST has undergone major transformations. In October 1965, the Departments of Applied Physics, Applied Biochemistry and Chemical Technology were established; the name of the faculty thus changed to the Faculty of Applied Science. In addition, a Department of Science was formed in the Faculty to teach sixth form science subjects. The University decided to reconstitute the Faculty to teach specialized courses in Biochemistry, Biology, Chemistry, Chemical Technology, Mathematics and Physics. At the same time, steps were taken to discontinue the Preliminary Science Courses, which ceased at the end of the 1968/69 Academic Year. Later, the Department of Chemical Technology was also transferred to the Faculty of Engineering under a new name, Chemical Engineering. The School of Graduate Studies took over the Board of Postgraduate Studies in 2000, with the responsibility for coordinating postgraduate programmes in the University. In October 2001, the School of Mines of KNUST in Tarkwah was elevated to a semi-autonomous institution called the Western University College. It has since October 2004 become a full-fledge University known as the University of Mines and Technology.
3.6. **Employment of KNUST Graduates**

Since its inception in 1952, KNUST has been at the forefront of training high quality university graduates for uptake in both the local and international job market. Graduates of KNUST are employed by all including governmental and non governmental agencies, international agencies and multinational companies across the globe. A classic example of how graduates of KNUST have deeply penetrated the international job market is the rise of one of its alumni – Kofi Annan – to the position of the Secretary General of United Nations. A well known and respected figure in international circles and winner of the noble prize for peace, Mr. Kofi Annan who had his first degree in Planning at KNUST steered the affairs of United Nations for 8 years. KNUST has produced nearly 42500 graduates in various disciplines in the last 10 years. Demand for tertiary education has risen considerably making KNUST to expand its programmes base and also increase the number of students enrolled considerably.

3.7. **Employment in the formal sector**

Tracer studies are not a major part of assessing the quality of University education in Africa. KNUST is no exception; no tracer studies have been conducted on her graduates, employment status to ascertain if trained graduates meet the aspirations of employers. National statistics indicate that as of 1988/1989, of the total number of employed people in Ghana with University degrees, 66.7% were employed in the public sector, 15.6% in the private sector and only 17.7% in self employment.

In a study conducted by the Ministry of Education in the then three public universities, namely, KNUST, Universities of Ghana and Cape Coast in1996, the following findings were published:

- 71% of all graduates found jobs in the first five months after their national service. In the case of the remaining 29 %, some took more than a year to secure employment;
- Of those who were employed, 61 % were employed by public sector; and 3 % by large private corporations;
- The unemployed were recent graduates and those who did not want to consider teaching;
- Though some had considered self employment, they only did that as a stop gap measure and were ready to move when opportunities availed themselves.

KNUST until recently had been known to be the only technical university in Ghana producing engineering graduates and other technical graduates like architects and planners. In a survey of over 3000 jobs advertised in the year 2000, Boateng and Ofori-Sarpong reported that Engineering and Technician jobs constituted about 15.8%. Meanwhile, arts and management related jobs constituted about 40% of the jobs advertised. They also found out that jobs requiring university graduates actually jumped from 30% in 1981 to about 45% of the total
jobs advertised in 2000. With regards to postgraduate studies, the study found out that only about 20% of the jobs advertised required post graduate degrees. Of these, a third required post graduate business degrees.

Engineering graduates especially were found to face very stiff competition from Higher National Diploma Polytechnic graduates because of the practical nature of their work. Even though Polytechnic graduates are usually placed lower in rank to university graduates with the same discipline, they are found handy by employers; moreover, they attract a lower fee.

3.8. Self-employment

Even though no research has been conducted to ascertain the number of KNUST graduates in self employment, numerous examples exist of illustrious alumni of KNUST. For instance a lot of pharmacists produced by KNUST have their own pharmacy shops and some doctors have been able to start their own private hospitals and clinics while some engineers also have been successful with establishing engineering services and consultancy based industries and some manufacturing firms. In the case of pharmacy, giant drug manufacturing firms like KAMA Group of Industries and Amponsah-Effah Pharmaceutical Industries were founded and owned by KNUST Alumni in the persons of Dr Michael Agyekum Addo and Mr. Amponsah-Effah respectively.

Globally, fresh graduate start-up businesses are a challenge due to plethora of problems. Poor management skills, lack of capital, lack of entrepreneurial training, harsh business climate are among a few issues that confront would-be graduate entrepreneurs. These problems either kill initiatives or snuff them out of business in their first years of operation. Ghanaian graduates are no exception. Starting up a business right after school is a big challenge.

In response to the needs of young entrepreneur's quest to start and manage their own businesses, KNUST has set up a Centre for Business Development (CBD) to train graduates to setup and manage their own businesses. The Centre also hopes to bridge the gap between academia and industry by linking the needs of industry to academia to reflect the training of would-be graduates.

3.9. Collaborations with other institutions

The University has many international collaborative links. Currently most Colleges/ Faculties/Departments/Research Centres have academic links with reputable foreign institutions of higher learning for either research and/or teaching.

3.10. Institutional collaborations
Research collaboration activities are usually established between the individual departments and colleges in the University. Almost all the departments in KNUST have some form of formal research collaboration with other institutions – local and abroad. Some of the research collaborations have led to staff training and upgrading like in the case of Mechanical and Agricultural Engineering Departments’ collaboration with North Carolina A&T University.

Others have led to the establishment of post graduate degree programmes in the various departments. A classic example is the collaboration between the Civil Engineering Department and IHE Water Institute at Delft in The Netherlands to establish a postgraduate programme in water and sanitation at KNUST. This programme has been instrumental in training high quality and responsible professionals in the water and sanitation area.

Also, the collaboration between the Civil Engineering and Indian Institute of Technology has led to the establishment of a post graduate programme in road and transportation. Some collaboration has been purely research oriented. An example is the collaboration between the Chemical Engineering Department and Columbia University to produce the next generation of sanitation engineers who will find innovative products from faecal sludge. Funded by the Danish Development Assistance, a project based postgraduate programme under the collaboration of Chemical Engineering Department of KNUST and the Technical University of Denmark on second generation biofuels is also expected to lead to the development of low-tech applications that can be easily deployed in producing lignocellulosic biofuels on a sustainable basis in Ghana.

The Energy Centre (TEC), a research entity under the College of Engineering, has spearheaded the development and promotion of technologies and policies on renewable energy and energy efficiency in Ghana and Africa. TEC has collaborated with both national and international organisations to undertake many projects in its thematic areas.

### 3.11. Collaboration with service and productive sector

The University has also established partnerships with institutions in Ghana, such as Anglo - Ashanti Gold, Tema Oil Refinery, VALCO Trust Fund, Unilever Ghana Limited, Standard Chartered Bank Ghana, Volta River Authority, Vodafone Ghana, Ghana Association of Bankers, and many more. These institutions support the University in various ways, including giving assistance to students for their project work. A Petroleum Chair for instance was established by Tema Oil Refinery at the Chemical Engineering Department to steer affairs in oil related research. Also, Unilever Ghana Plc, awards the best graduating engineering and chemical engineering student with a prize.

### 3.12. Research and Development Activities
Being the premier Science and Technology University in Ghana, KNUST strives to break new grounds in science and technology to contribute towards the socio-economic development of the country and Africa. Since its establishment, several science, technology and innovative activities had been undertaken in KNUST. This section describes a selected few of innovative research activities that have been undertaken by scientists and engineers at KNUST.

a) **Introduction of a new cassava variety**

‘Tek Bankye’ as it is popularly known is the first cassava mutant variety in the world and was produced by Prof. Safo-Kantanka of the Agriculture Science Department in 1997. This cultivar has an excellent cooking quality and is easy to good pound. It also has very high dry matter content of about 40%, and very popular among cassava growers.

![Caption from technocrat magazine showing Prof Safo-Kantanka admiring “Tek bankye”](image)

The CDIAR institutions, particularly, IITA had carried out very good research, leading to the release of high-yielding and disease-resistant varieties, but for a long time Ghana could not take advantages of these new varieties because they did not possess the desired cooking qualities for Ghanaian preparations such as Fufu and Ampesi. The motivation for this research on cassava therefore was to understand the factors that controlled the cassava cooking quality. His mutation breeding study started in 1987, and was supported by the International Atomic Energy Agency. The research involved among other things, the radiating of some IITA cassava genotypes with Co-gamma rays.

Through the use of the radiation on the cassava genotype, some changes were made in the genotype, which ultimately led to changes in the starch granule size, which also affected cooking quality. The research team was thus able to select materials with good cooking qualities for fufu. With the support of the Crop Services Department of the Ministry of Food and Agriculture (MOFA), this material was tested throughout the country. This cassava mutant

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7 Fufu is an indigenous food prepared by pounding cooked cassava or yam.
was high-yielding and fairly tolerant to diseases, and could be used for fufu and ampesi\(^8\). The new cassava variety was released in 1997 as ‘TEKBANKYE’ – literally meaning KNUST’s Cassava.

It is worth mentioning that according to the IAEA mutant variety database, ‘Tek bankye’ was the first and the only cassava mutant variety in the world as at 1997.

![Image of Prof Safo-Kantanka holding a sample of the cassava mutant variety.](image)

**Figure 2:** Prof Safo-Kantanka holding a sample of the cassava mutant variety.

In a related development, the achievement of Prof Safo-Kantanka, prompted the IAEA to support the research team with basic equipment to set up the first tissue culture laboratory on KNUST campus. Roots and tubers, which had been previously neglected, received a boost in the form of financial support from the government of Ghana and IFAD to develop and disseminate technologies on these crops through the Root and Tuber Improvement Program (RTIP). Prof Safo-Kantanka who coordinated the first phase of RTIP which ended in 2004 made further achievements in his root and tuber research. In May 2003, they released a new variety of sweet potato, ‘Tek Santom’. This produces 18-20 tons/ha, has diseases resistance, high dry matter, yellow-fleshed, low sugar content and is very mealy.

Through the collection and screening of cassava Germplasm from Brong Ahafo, two new cassava varieties were released and are resistant to the African Cassava Mosaic Virus Disease (ACMVD) and are high-yielding, with high dry matter and of good cooking quality. The two varieties were officially released in August 2003 and they were named ‘IFAD’, in recognition of IFAD’s support; and NKabom (Unity) to reflect the collaboration between the research team and MOFA personnel in carrying out the research.

### 3.13. Design of the first integrated circuit in sub-Saharan Africa

As part of the KNUST’s partnership with Texas Instruments and Texas A&M University, three final year students from the erstwhile Faculty of Electrical and Computer Engineering, KNUST

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\(^8\) Ampesi is also a traditional meal of any boiled root or tuber or plantain.
get the opportunity to spend a semester at Texas A&M University, where they are given the foundations of VLSI or microchip technology. Through this collaboration, two students, Noble Narku-Tetteh and Eugene Foli made history by successfully designing the first integrated circuit in sub-Saharan Africa (outside South Africa) in the Texas Instruments sponsored Cadence Micro-electronics Laboratory in KNUST. The two chips, the KNUST_INAMP IC and the KNUST POWERSAFE IC have been successfully fabricated and have passed preliminary functional tests. Below is a brief description of both ICs.

a) The KNUST_INAMP IC
In medicine, precision is critical. The difference between life and death could be bridged by the smallest error margins. Unfortunately most of the signals (e.g. heartbeat, muscle contractions etc.) that the body presents are too small and weak (especially if they are coming from a sick person) to be meaningfully interpreted by the human senses with the required level of precision. This suggests that some sort of amplification device is needed to boost these signals to levels that can be readily appreciated during medical diagnosis. This is where the KNUST_INAMP IC comes in. The IC can take in extremely small voltages and boost them up to about 50 times their original magnitudes! The level to which the input signal can be boosted can be controlled by the user. The IC can be used in all medical instrumentation applications where amplification is required, e.g. ECGs, EEGs, EOGs, etc. In a nutshell, the IC serves to amplify weak and small amplitude signals to a much more appreciable level.

![A picture of an input signal (in green) and its magnified output signal (in blue) using the KNUST INAMP IC](image)

b) The KNUST POWERSAFE IC
The Ghanaian market is no stranger to appliance protection devices. Fridge guards, TV guards, and other protective devices have become so common in the Ghanaian market that it would be unusual to find a household that didn’t possess one. These devices have become necessary due to the rampant and potentially harmful voltage fluctuations (voltage surges and voltage drops). To protect our devices from such voltage fluctuations, it is necessary to disconnect our appliances from the power supply, when the fluctuations occur. The KNUST POWERSAFE IC does just that. It constantly monitors the voltage level and disconnects our appliances when the supply voltage becomes too high or too low. It re-connects the appliances when the voltage returns to normal. With this IC we don’t have to worry about our appliances when we are at work.

The IC, while it performs the task of the appliance protection devices on the market, is integrated onto a single chip and is thus less bulky and more efficient. It works by taking in an AC supply as input and compares this input with a preset threshold range. If the input falls out of this range (i.e. if the input is higher than the upper threshold limit or is lower than the lower cut-off limit), the IC disconnects whatever load is connected to it (i.e. your fridge, TV, air condition etc) and reconnects the load when the power supply returns to normal working range. The KNUST POWERSAFE IC simplifies existing bulky designs and also offers a more efficient protection for electrical appliances against voltage surges.

![KNUST POWERSAFE IC mounted on an IC socket](image)

**Figure 4:** KNUST POWERSAFE IC mounted on an IC socket

The two chips were designed fully in KNUST but were fabricated and packaged by MOSIS in the USA. Currently both designs have passed preliminary functional tests and are undergoing detailed characterization tests. Some final year students are using some of the ICs in their final year project works. Work has also begun on the design of two new ICs that will use the core of the KNUST POWERSAFE and INAMP ICs.
c) MINI BAJA project

In May 2003, the Mechanical Engineering Department of KNUST out-doored its first ever off-road vehicle at the Kumasi Auto Rally. The vehicle named “AKUAFO ADANFO” meaning ‘the farmers’ friend’, will among others assist in the carting of agricultural produce and other goods when a trailer is fixed to it. Mechanical engineering students displayed and drove the first Mini-Baja car built by KNUST students along with a similar Mini-Baja built by NCAT students.

![Figure 1: A Mini-Baja](image)

These All-Terrain Vehicles (ATV) were designed following the rules from the Society of Automotive Engineers for American Mini Baja competitions could help farmers in Ghana transport products from rugged, rocky terrain to urban markets. This new technology is solving some of Ghana’s agricultural transportation problems.

![Figure 2: The Project partners](image)

This project is a result of collaboration between ALCOA foundation, North Carolina Agriculture and Technical State University and Kwame Nkrumah University of Science and Technology.
d) Mechanical Cassava Harvester in Ghana

Cassava is a major staple food in Ghana used to prepare many dishes popular among them is “fufu”, enjoyed across the length and breadth of the country. In spite of its popularity, there are still major challenges facing its production process. One of the key inhibitors to large scale cassava farming is mechanical harvester. At the moment manual effort is employed in the harvesting process that is both tedious and very inefficient especially when commercial production is considered.

To address the above problem, the Department of Agricultural Engineering, KNUST, in conjunction with the Agricultural Engineering Department of Leipzig University, Germany, have been collaborating since 1992 in the development, field-testing and evaluation of a tractor-mounted mechanical cassava harvester. Named “Tek Mechanical Cassava Harvester”, the implement which is attached to a tractor, goes down about 12 inches to uproot the cassava and also ploughs the farm in the process. It can cover a hectare of land within two hours.

The first prototype mechanical harvester was tested in Ghana from 1992-1994, yielding positive functional results. Initial results obtained indicated that the harvester produces a high draft value when in operation. Other parameters found to be on the high side include the fuel consumption, the slip and tuber damage. On the positive note, the field capacity is appreciably high especially under very dry soil conditions (AGRIS, 2011)

A proposal to undertake further evaluation of the harvesting technique was sponsored by NARP Technical Secretariat, CSIR. The support was to enable further data to be collected, the possible development of downsized versions and to compare performance with manual harvesting methods. The original Leipzig prototype and a second modified version developed were tested on cassava fields in the Arable Section of the Faculty of Agriculture, KNUST, Kumasi. The two prototypes were tested and compared in the areas of draft requirement, fuel consumption, tuber damage, field any modifications necessary without tampering with the original prototype. This is to incorporate any modifications in newer prototypes till favourable results are obtained. This necessitated the establishment of cassava fields to provide sufficient test plots for more experiments to be carried out.

According to Dr. Bobobee, the brain behind the project, “agricultural labour is aging and what we need to reduce drudgery is innovation and mechanization such as the use of the implement.” (www.newtimes.com).

e) Biochar Reactor for the Production of a Biochar for Soil Amendment

One of the key challenges of the present African generation is food security and sustainable agriculture as a result of the effect of climate change. Ghana is no exception to countries in Sub Sahara Africa facing these problems. Indigenous knowledge has that farmer’s report of high crop yield when they grow their crops in areas abandoned by charcoal producers. A soil
profile of the Amazon revealed a thick black pure carbon layer which gives the soil such potent characteristics. The research seeks to produce this pure carbon using agricultural waste which is in abundance and can be readily obtained.

The objective of the research was to design, build and test a pilot biochar reactor to convert biomass into biochar and syngas. A pilot plant was built and tested using sawdust and rice husk as the raw materials. Tests conducted on the biochar produced revealed high porosity which is a good property as it defines its ability to retain moisture and by so doing prevent the leaching away of essential nutrients. In recognition of the importance of the research to national development, the Government of Ghana through the Ministry of Science and Technology has ordered for 10 prototypes to be situated in the ten regions on selected farms of individual farmers by the Chemical Engineering Department. This research is being carried out by Lecturers in the Chemical Engineering Department and researchers from the Soil Research Institute of CSIR and the Biochar Society of UK.

f) Photo production of Hydrogen: Design, Operation and Performance of Integrated PV-H2 stand alone power system

Even though national access to electricity is quite high as compared to other Sub-Saharan African nations, there is still a large portion of Ghana’s population who are not connected to the national grid. Interventions in such areas have focused on supplying stand alone solar PV systems to some of the affected communities either as a Government of Ghana project or a donor funded project. Most often than not apart from the initial cost being a major inhibiting factor, the cost of maintenance and replacement of the batteries are a major source of worry for potential users who in most cases are poor. The project sought to integrate a fuel cell into a solar PV system so that excess energy can be stored in the form of hydrogen which can be used to power a fuel cell to charge a battery or provide additional power during sunset.

The objectives of the projects were to;

- Produce H₂ gas using a 50 W, 12 V solar PV system through the electrolysis of water;
- Design and fabricate a Proton External Membrane (PEM) fuel cell using alternative materials;
- Test the stand alone hybrid system; and
- Determine the combination of materials that gave the best results.

During the testing phase a 600 W personal computer and a 6 W lamp were connected simultaneously to the system and for more than 30 minutes. The battery’s voltage was 12.19 V before the experiment and it reduced to only 11.57 V for the entire period even though the battery was not being charged.
Also, Al-C/Pt – PEM-C/Pt-Cu results showed that Al and Cu were suitable conducting materials for hydrogen fuel cells.

g) Liquid Chromatography and Mass Spectrometry Methods for the determination of triglycerides in Corinifer Seed Oils

Identification of triglycerides and their exact position on the glycerine backbone has been a major challenge for chemists for some time. Even though some methods have been developed in the past there has always been a level of uncertainty associated with these methods that made them not suitable. The type of triglyceride in a fatty acid and its position are critical for determining the physical and chemical properties of the oil.

The objectives of the research were to develop methods to first all separate and identify each triglyceride present on the glycerine backbone, characterize each triglyceride and determine its position on the glycerine backbone. This project is very important to national development especially when Ghana is still struggling to choose the feedstock to promote for its biodiesel programme. Once methods are developed for Corinifer seed oil, other methods can be developed for other seed oils that are abundant in the country. New methods were developed for identifying triglycerides in seed oils using Liquid Chromatography and Mass spectrometry methods. Methods were developed for identifying the position of the triglycerides on the glycerine backbone using Chromatography and Mass Spectrometry methods.

3.15. Conclusions

The Kwame Nkrumah University of Science and Technology has since its establishment devoted efforts into capacity building and skills acquisition in many academic areas for the creation of sustainable skills for national development. It has produced high quality graduates for the labour-market and has contributed immensely to knowledge. KNUST is the premier science and technology tertiary institution in Ghana offering unique degree programmes, many of which are not available in the other universities in the country. These programmes are, among others, Architecture, Building Technology, Engineering (Aerospace, Agricultural, Chemical, Civil, Computer, Electrical and Electronic, Geomatic, Mechanical, Petroleum, and Telecommunication), Herbal Medicine, Integrated Rural Art and Industry, Industrial Art, Land Economy, Pharmacy, Planning, Publishing Studies, Renewable Natural Resources, Sports and Exercise Science, and Wood Science and Technology. It has faculty members who are highly qualified in their respective disciplines.

The University has several partnerships with other institutions. Research collaborations are usually established between individual departments and colleges in the University. Almost all the departments in KNUST have some form of formal research collaboration with other institutions – local and abroad. Some of these collaborations have led to the establishment of postgraduate programmes.
The University does a lot of research through students project work. Each year final year students are required to undertake some research activity under the supervision of Faculty. Some of these research activities are further developed at the postgraduate level resulting in innovative products of national and global relevance. Some of these activities have been highlighted in section 3.4 above.

KNUST, however, faces several challenges in its quest to develop capacity in science and technology, as summarized below.

  a) Inadequate funding for research
The University has not diversified its sources of funding. It has been depending mainly on Government sources for funding for its general operations and donor funding for R&D activities with little income from industry and other sources. This makes it difficult to offer incentives to its staff, allocate adequate funds for research, and maintain its infrastructure and equipment.

  b) Run-Down Infrastructure
As a result of inadequate funding, existing infrastructural facilities have not been effectively maintained over the years, and the laboratories, teaching facilities and equipment have seen rather little upgrading to keep pace with rapid changes in technology.

  c) Inadequate Information and Communication Technology (ICT) Infrastructure and Facilities
The University has limited communication facilities and inadequate access to the Internet. This limits access to information and the marketing of University activities and staff potentials. As a science and technology institution, the inadequacy of such IT facilities is a very serious drawback on academic and community service functions. The limited IT facilities constitute a disincentive to potential collaborators and also create a poor corporate image. It also reduces efficiency in all aspects of University activities.

  d) Weak Inter-Faculty Collaboration
The faculties do not collaborate much with each other and, as a result, some research programmes and courses are duplicated. There are limited inter-faculty lectures and attendance at the few is poor.

  e) Inadequate Staffing
The increase in student numbers without the corresponding increase in staff strength has overburdened the staff. This is affecting their ability to perform optimally in terms of teaching and research.
3.16. Recommendations

In order to achieve greater heights as a leader in applied research in science and engineering, as well as in the humanities in Ghana and Africa, KNUST should:

• Support multidisciplinary applied research and development among researchers in the various Departments by setting aside more internally generated funds for research;
• Introduce policies that encourage young graduates to return to the Departments as technicians, demonstrators, lecturers and researchers in order to learn from the experienced teaching staff;
• Quickly promote deserving teaching and research staff. Staff members who show a track record in research and development via relevant publications in reputed refereed journals should be promoted strictly based on laid-down regulations. Similarly, lecturers that fail to obtain the minimum number of publications for a given period should be penalized based on regulations of the University. This will ensure that KNUST gets the best in terms of teaching staff which also translates into well-trained graduates;
• Encourage inter-faculty research on common themes in order to build team work and strong ties among researchers and students from various Departments. Such collaborations will enable the Faculties to churn out innovative products and inventions that will benefit society and also gain glory for the institution;
• Reward teaching staff who demonstrate excellence in teaching. Rewards can be based on student assessment of lecturers as well as assessment from colleague lecturers. Similarly, those that fail to demonstrate excellence in teaching based on assessment by students’ and colleagues should be sanctioned;
• Encourage researchers to build partnerships with national institutions, developmental partners, local and international NGOs, CBOs, and the private sector and to work on common themes that would benefit the wider community;
• Aggressively pursue infrastructural development. Modern laboratories, lecture rooms, ICT facilities, staff offices should be given premium attention if the institution is to continue to lead the way for Ghana as far as science and technology education and training are concerned;
• Ensure that its research outputs are open and are made available to the public. KNUST has not done much in telling the success stories of its researchers whose works are mostly found on the shelves at the various Departments. While attempts have been made by Graduate School to put electronic copies of graduate research projects online, access has been difficult due to restrictions. Moreover, only few projects have been made available online. This has created a dearth of knowledge as major research work in the form of MSc, MPhil and PhD thesis are shelved, known to just a few; and
• Encourage the Departments to introduce flexible programmes that enable students to enroll in courses any time in a year. Whenever necessary, students should be able to
participate in classes away from the boundaries of the institution with the aid of information technology.

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www.knust.org


ANNEX: KNUST STRATEGIC PLAN AND POLICIES

A.1 Introduction

On the initiative of the Government of Ghana, the University has recently embarked upon an exercise to transform itself into an efficient, contemporary, high quality national institution in science and
technology that would serve as a key platform for the industrial and socio-economic development of the country. In the light of the harsh economic conditions that the country has been experiencing, this would help to sustain and strengthen the institution. It will also enable it to respond to the increased pressure that many institutions in Ghana and other countries have been under, to reduce their dependence on central government for the required resources for their operations. Under the National Institutional Renewal Programme (NIRP) of the Public Sector Institutional Transformation in Ghana, KNUST is one of the institutions that are expected to reduce their dependence on Government subvention, to diversify revenue sources and to partially become commercial. Moreover, given that the stakeholders of the University are themselves facing difficult choices as a result of reduced financial support from government; such a transformation should help to greatly renew their faith in KNUST, as an institution ready to face the challenges of the twenty first century.

Accordingly, a Strategic Plan Preparation Committee was commissioned to prepare a strategic plan dubbed PLAN2K10. It became necessary for the University to take another look at the Strategic Plan (PLAN2K10) in order to capture and include the vision and policy measures of a new, who, as the academic and administrative head of the University, is responsible for the implementation of the Strategic Plan, hence the need to revise PLAN2K10. The updated PLAN2K10 takes into account the initiatives of the Vice-Chancellor and other new developments since it was first prepared under the leadership of the former Vice-Chancellor. This new version of the plan is dubbed PLAN2K14.

Having been in existence for a little over half a century, the University is confronted with four major questions:

- What should be done to ensure a meaningful role for the University, amplify its relevance and optimally position it for the millennium?
- Should the original objectives be reinforced, modulated or radically altered?
- Considering the fact that a greater part of the University’s resources is spent on teaching and guiding students, should the University charge the students the full cost of their training, which could be borne by Government, or by Government with private sector participation, or directly through fee-paying by students; and
- How could the University diversify its sources of income and reduce its dependence on Government?

The objective of the Strategic Plan for KNUST (PLAN2K14) is to address these and other related issues. It utilizes an understanding of KNUST’s rich history and strengths to marshal its resources and energize all its constituent parts to meet the present as well as any ensuing challenges.

### A.2 Plan period

To concretize the change from the existing environment towards the attainment of the objectives of the University, short-term, medium-term and long-term targets are defined. These targets would be realized through projects with measurable deliverables, milestones, and identified responsibilities for their constituent parts. As part of the overall planning strategy, detailed guidelines have been prepared to guide the Colleges and the other Units in the preparation of their medium term and action plans. These medium term and action plans are intended to facilitate the realization of the vision and strategic objectives of the corporate plan of the University.

This Strategic Plan covers the period 2005 to 2014 and it is in three phases as follows:

2. The medium-term (2008 – 2011), and
A.3 Situation assessment

To accomplish the University's objectives, it is important to leverage the environment, and to that end are the Strengths, Weaknesses, Opportunities and Threats (SWOT) analyses. It is important to identify areas of opportunity where the strengths of the University could be applied for maximum advantage while managing the constraints or threats. Complementarily, the weaknesses represent gaps that need to be filled if the University is to take advantage of the opportunities. Alternatively, the areas of weakness could signal potential areas of divestiture. Given the competition for resources, these could help the University to better focus the scope of activities to increase the likelihood of excellence in execution. The output of the SWOT analysis is presented in this Section.

A.3.1 Strength

KNUST is one of the public universities in Ghana and Africa offering training programmes in the fields of science and technology. It has a very strong social science input into the science and technology programmes. Public perception of KNUST in Ghana and elsewhere is quite high. The University is internationally recognised and has a good image and reputation. This is reflected in the collaboration it has with similar universities outside Ghana and the patronage of its programmes by both Ghanaian and international students. It has faculty members who are highly qualified in their respective disciplines and a cadre of administrative and supporting staff that ensure high quality training programmes. In addition, the University is blessed with a peaceful environment and a good infrastructure, which, if properly supported and maintained, could be first-class. Among the specific areas of strength are the following:

a) Quality of Faculty Members and Staff

About 40 percent of the faculty members hold doctorate degrees and the remainder have masters degrees. They have varied backgrounds in terms of expertise and where they received their training, which helps to promote a global, multi-disciplinary outlook on campus. Almost all the senior administrative staff have had postgraduate training. In addition, most of the faculty members and senior administrative staff belong to various national and international professional bodies.

b) Good Image and Reputation

The University continues to attract a large number of applications to the various programmes. Since its elevation to the present status in 1961, it has been responsible for the training of a high percentage of graduate personnel in various fields of activity such as teaching, research and industry in Ghana. Policy makers and employers have a high regard for the Alumni of this University for their good performance.

c) Unique Programmes in Ghana

As the premier science and technology tertiary institution in Ghana, it offers unique degree programmes which are not available in the other universities in the country. These programmes are Architecture, Building Technology, Engineering (Aerospace, Agricultural, Chemical, Civil, Computer, Electrical and Electronic, Geomatic, Mechanical, Petroleum, and Telecommunication), Herbal Medicine, Integrated Rural Art and Industry, Industrial Art, Land Economy, Pharmacy, Planning, Publishing Studies, Renewable Natural Resources, Sports and Exercise Science, and Wood Science and Technology, among others.

d) Collaboration with Institutions of Higher Learning and Research

The University has many international collaborative links. Currently most Colleges/Faculties/Departments/Research Centres have academic links with reputable foreign institutions of higher learning for either research and/or teaching. It is also a member of prestigious associations such as the Association of African Universities (AAU).
e) Environment and Infrastructure
The campus of the University has modern buildings interspersed with beautiful lawns and tropical flora, which provide a suitable atmosphere for academic work. Almost all the Faculties have permanent building complexes containing offices, laboratories/studios, classrooms and lecture theatres, as well as specialized libraries. Other facilities include the University Library, the Great Hall, the halls of residence for students, the Paa Joe Stadium, Guest Centres, Sports Centre and a complex for banking and other commercial activities.

f) Access to Large Stretch of Land
The University has a large stretch of land that can be utilized for the development of facilities and research farms to support the training of students and identified stakeholders in various disciplines in consonance with Government policy.

A. 3.2 Weaknesses
In spite of the many strengths of the University, there are distinct areas where significant improvement is needed if the objectives are to be achieved. These are discussed below.

a) Inadequate Funding and Poor Allocation of Resources for Academic Programmes
The University has not diversified its sources of funding. It has been depending mainly on Government sources for funding without making sufficient efforts to generate income from industry and other sources. Unfortunately, Government subvention is usually inadequate and dwindling, and is not released on time. This does not make for efficient planning and execution of tasks. Other consequences of the limited funding of the University are the lack of means to offer incentives to its staff, allocate adequate funds for research, maintain its infrastructure and equipment, and expand its lecture theatres and office accommodation.

b) Run-Down Infrastructure
As a result of inadequate funding, existing infrastructural facilities have not been effectively maintained over the years, and the laboratories, teaching facilities and equipment have not been upgraded to keep pace with rapid changes in technology.

c) Poor Remuneration and Poor Service Conditions for Staff
Remuneration for the staff of the University is lower than what pertains in some public and private sector institutions in the country. The low level of remuneration is seriously affecting commitment and performance of the staff of the University. Also due to the inadequate remuneration and conditions of service, the University is not able to attract younger staff and retain the experienced ones.

d) Inadequate Accommodation for Students and Staff.
About 53.2% of the students are non-resident and some live in substandard accommodation in the suburbs of Kumasi. The remaining 46.8% live in overcrowded cubicles in the halls of residence, thus putting pressure on facilities. Accommodation for staff is also inadequate.

e) Inadequate Information and Communication Technology (ICT) Infrastructure and Facilities
The University has limited communication facilities and inadequate access to the Internet. This limits access to information and the marketing of University activities and staff potentials. As a science and technology institution, the inadequacy of such IT facilities is a very serious drawback on academic and community service functions. The limited IT facilities constitute a disincentive to potential collaborators and also create a poor corporate image. It also reduces efficiency in all aspects of University activities.
f) Inadequate Orientation for Management Staff in the Academic Units
Usually the management staff of the academic units is appointed/elected without the requisite orientation. They often acquire management skills on the job and this creates administrative problems, especially during the first few months in office.

g) Inadequate Staffing
The increase in student numbers without the corresponding increase in staff strength has overburdened the staff. This is affecting their ability to perform optimally in terms of teaching and research.

h) Weak Inter-Faculty Collaboration
The faculties do not collaborate with each other and, as a result, some research and courses are duplicated. There are limited inter-faculty lectures and attendance at the few is poor.

i) Weakness in English/Communication Skills of Students
Students tend to have very poor writing skills well and limited vocabulary, and as a result they are unable to write good essays and reports.

A.3.3 Opportunities
Notwithstanding the weaknesses identified, there are many opportunities available to be exploited to fulfill the University's vision and mission. These include:

a. Academic Link Programmes
Opportunities exist for the University to collaborate with international organizations and institutions both bilateral and multilateral.

b. Consultancy Services
Consultancy services are available within the public and private sectors. Currently, many organizations within the country rely on consultancy services for their operations. The University can therefore take advantage of this favourable environment and provide consultancy services for these organizations.

c. Collaboration with Industry
The industrial sector and the public utility providers face problems that require urgent solutions. The Colleges of the University can collaborate with the respective sector industries to find solutions to these problems to promote socio-economic development of the country.

d. Professional Associations
They provide a bridge between industry and the University. They can serve as moderators for the academic programmes to make their contents more relevant to national needs, and also support practical training of students.

e. Distance Education
Government and international bodies are receptive to the Distance Education concept. The University should take advantage of this and intensify its programme of offering distance education courses.

f. Continuing Education
Governmental agencies and Non Governmental Organisations (NGOs) are willing to sponsor continuing education programmes in the form of short courses, workshops and seminars to upgrade the skills of
their employees. The University will intensify efforts to meet this demand and expand service to the community.

g. **Income Generation**
Income generating potentials exist within the University. These should be developed and expanded and the income so generated would be used to supplement government subvention.

h. **Market for Appropriate Technology**
A market for technology in support of small-scale industry and traditional production systems exists in Ghana. Community-based small-scale projects are a priority of government and international bodies. KNUST can take advantage of this to offer services and generate income.

i. **Interaction with Alumni to Attract Resources**
The University has a large pool of Alumni in strategic positions both within and outside the country. The University should therefore strengthen her links with the Alumni in order to reap the full benefits of the relationship.

j. **Numerous Forest and National Parks**
Virtually all the forest reserves, national parks and traditionally protected areas are available to the University staff and students as field laboratories for teaching and research. Ghana has 18 terrestrial and five (5) marine wildlife protected areas, 216 forest reserves in the high forest zone and 50 in the Savannah zone with rich flora and fauna diversity of high global conservation interest. In addition, the University has access to numerous fresh and marine water bodies, which are not available in many countries.

k. **Vacation/Summer Programmes and Study Abroad**
A number of Faculties and Departments have exchange programmes with some overseas and local institutions under which courses, workshops, etc. are mounted in the summer. These could be expanded and effectively managed to generate additional income for the university.

l. **Location of the University**
The location of the University in Kumasi with its cultural status and industrial set-up offers additional opportunities. The industrial set-up of Kumasi, comprising mainly small-scale industries at the Suame Magazine and the wood processing industries at Ahinsan, offer challenges to KNUST to play a leading role in capacity building and appropriate technology development and transfer. The opportunity exists for Research and Development (R&D) to support the industrial base of the Kumasi Metropolitan Area and Ashanti Region in particular.

A.3.4 **Threats / challenges**
The external factors that adversely affect the University in the performance of its task of teaching, research and service to the community include the following:

a. **Inadequate Government Subvention**
Since the implementation of the Educational Reform Programme in 1992, there has been a rapid increase in student enrolment without the requisite increase in government subvention. This imposes a great limitation on the university in the pursuit of her objectives.

b. **Government Policy on Wages/Salaries and Student Allowances**
Generally, wages/salaries and student allowances are low in comparison to cost of living. The resultant agitations from unionized groups during negotiations with government for better conditions of service culminate in disruption of academic work. Similarly, unrest by students due to delays in
meeting their demands from government and the university administration also leads to disruption of academic work.

c. Poor Communication Skills of In-coming Students
Candidates admitted into the University generally have weak communication skills. The situation is similar to having defective materials in a manufacturing process. Valuable time is therefore spent in making good their various deficiencies.

d. Lack of Corporate Identity for Colleges and Units
Currently government ministries, departments and agencies, and some bilateral and multilateral agencies require that only registered consultancy firms should be considered for engagement for consultancy services. This conditionality limits the avenues for consultancy services of the various colleges and units of the University.

e. Emergence of Private Universities
The emergence of private universities in the country poses a challenge to the University in attracting and retaining experienced staff, and more external support.

A.4 Ghana government’s objectives for higher education sub sector

The Government’s objectives for higher education sub sector focus the work of the University and provide the framework within which the KNUST objectives are developed. These objectives are as follows:

1. Expand and improve post-basic education;
2. Promote Distance Education;
3. Prioritize female education at all levels including technical and vocational education;
4. Promote academic and research activities relevant to national development in collaboration with the private sector;
5. Promote the dissemination of research findings for development;
6. Identify and promote STD/HIV/AIDS prevention, care and support at all levels of education;
7. Ensure relevant education and training for employability;
8. Promote science, mathematics and technology education and training; and
9. Promote Information and Communication Technology (ICT) in schools and institutions of higher learning.

A.5 The University’s strategic objectives

The general objectives of the University are driven by the national objectives for higher education. To meet the national aspirations and expectations, the University has adopted 15 operational objectives under five strategic objectives that have been grouped into five themes for the plan period (2005 – 2014). The themes and the strategic objectives are presented below in the order of priorities:

A.5.1 Thematic areas

1. Human Resource Development;
2. Financial Resources Mobilization and Management;
3. Training, Research and Innovation;
4. Expansion and Application of ICT; and
5. Physical Infrastructure Development
A.5.2 Strategic objectives

The thematic areas have been translated into strategic objectives with the accompanying operational objectives, and they are as follows:

1. To develop high level human resource capacity required by the University to fulfill her mission;
2. To improve financial resource mobilization and management;
3. To provide manpower training, research and innovation in science & technology for national development;
4. To expand the IT infrastructure and institutionalize its application in the core business of the University;
5. To expand and modernize the physical infrastructure and facilities of the University

A.6 Expected outputs

At the end of the plan period, the plan is expected to achieve the following key outputs:

1. Sustainable financial base for the development of the University;
2. Efficiently maintained and modernized infrastructure and facilities (including expanded Information and Communication Technology facilities);
3. Adequately remunerated staff;
4. Highly qualified and experienced academic staff attracted and retained;
5. Developed technical and management staff to support teaching and research;
6. Restructured faculties and improved management of the University;
7. Expanded academic programmes (especially, the post graduate studies) and avoidance of duplication of activities (teaching programmes and research projects);
8. Students and researchers attracted from both local and foreign sources;
9. Collaboration and support from industry and alumni;
10. Expanded residential facilities (Halls of Residence and Hostels for students, and staff housing; and
11. Developed departments/units that have the potential to generate income and divest municipal services that constitute a drain on University finances.
CHAPTER 4

Initiatives for Skill Formation in Science, Technology and Innovation in Kenya; A case Study of Jomo Kenyatta University of Agriculture and Technology (JKUAT)

By: Prof. Anselimo O. Makokha

4 Summary

The Jomo Kenyatta College of Agriculture and Technology (JKUAT) is situated 35 km to the North East of Nairobi, along the Nairobi Thika Highway. It was started as the Jomo Kenyatta College of Agriculture and Technology (JKCAT) sponsored by the Government of Kenya as an institution of higher learning, starting mainly with training at diploma level in 1981. It received university accreditation in 1994, when it became a full fledged public university in Kenya. The University started off with a strong reputation in the sciences, agriculture, technology and engineering. It has made a lot of efforts in these fields to maintain the reputation over the years. It currently comprises seven schools and faculties, mostly science and technology based, and four institutes. Among the key innovations by the university include pioneering the production of tissue culture bananas in the East African region, fabrication of the Walking Tractor, fabrication of the ECO Block Making machine, fabrication of a fruit pulper, and development of unique food and chemistry based products based on locally available raw materials. The university has also been involved in dissemination of technologies and innovations through training entrepreneurs and special groups including women groups. Such dissemination includes training in ICT, food analysis, food product development and training in mushroom production. JKUAT graduates enjoy high demand among employers, particularly in engineering and ICT. The graduates are trained for both formal and self-employment. Graduates in all courses are equipped with entrepreneurship skills. A few of the graduates have made a global mark in making useful innovations themselves, with one of them having been awarded the CNN hero of the year 2010 for his adaptation of solar lantern lamp for use in rural areas of Kenya.

a) Vision and Mission

The **Vision** of the University is to be a world class institution of excellence for development. The **Mission** of the University is to produce leaders in training, research and innovation in the fields of agriculture, engineering, technology, health sciences and enterprise development to suit the needs of a dynamic world.

The **core functions** of the university, as stated in the University Service Charter (JKUAT, 2008) are:
• **Training:** To provide directly or indirectly, or in collaboration with other institutions of higher learning, facilities for University education and training for effective application of knowledge and skills to the life, work and welfare of the citizens of Kenya, and for the socio-economic development of the country.

• **Research:** As part of the University’s mandate to generate, store and disseminate knowledge, JKUAT has created an enabling environment and policy framework for undertaking high quality and relevant research.

• **Innovations:** The University has mainstreamed innovations and recognition of intellectual property rights.

• **Community service:** The University participates in community programmes and activities as part of its corporate social responsibility.

b) **Strategic Goals**

The strategic goals of the University as per the current Strategic Plan covering the period 2009 - 2012 (JKUAT, 2009) are as follows:

- Provide access to quality and relevant higher education to contribute towards development needs of a dynamic world.
- Ensure that academic programmes provided meet high quality standards and are relevant to socio-economic and political needs of the society.
- Strive to maintain reputation where research and innovation meet global standards.
- Ensure an effective, efficient and sustainable management of resources.
- Invest and engage in productive collaborations with national and international institutions and industry.
- Contribute to the country's industrialization and socio-economic development through provision of demand driven extension services, and transfer of appropriate technologies.

The first group of students was admitted on 4th May 1981, and the first graduation ceremony was held in April 1984. The two main faculties at the establishment period were the faculties of Agriculture and Engineering. The faculty of Agriculture had three departments: Department of Agricultural Engineering, Department of Food Science and Department of Horticulture. The faculty of Engineering also had three departments: Civil Engineering, Electric and Electronic Engineering and Mechanical Engineering. The first batch of diploma graduates specialized in the fields of Agricultural Engineering, Food Technology and Horticulture. From this humble beginning, the University has since grown into seven schools and four institutes. The University started off with a strong reputation in the sciences, agriculture, technology and engineering. It has made a lot of efforts in these fields to maintain the reputation over the years. However, it has also diversified into business and social sciences courses. An overview of the current programmes is given in section 3 of this Chapter (JKUAT, 2011).

c) **Academic Programmes: Schools, Faculties, Departments and Institutes**
a) I: School of Mechanical, Manufacturing & Materials Engineering (SoMMME)
   a) Department of Mechanical Engineering.
   b) Department of Mechatronic Engineering.
   c) Department of Mining and Mineral Processing Engineering.
   d) Biomechanical and Environmental Engineering Department.

II: School of Electrical, Electronic & Information Engineering (SEEIE)
    a) Department of Electrical and Electronic Engineering.
    b) Department of Telecommunication and Information Engineering

III: School of Civil, Environmental & Geospatial Engineering (SCEGE)
     a) Department of Civil, Construction and Environmental Engineering
     b) Department of Geomatic and Geospatial Information Systems

IV: Faculty of Agriculture
    a) Department of Food Science and Technology
    b) Department of Horticulture
    c) Department of Land Resource Planning and Management

V: School of Architecture and Building Sciences

VI: School of Human Resource and Development

VII: Faculty of Science

VIII: Institutes
     • Institute of Computer Science and Information Technology (ICSIT).
     • Institute of Tropical Medicine and Infectious Diseases (ITROMID).
     • Institute for Energy and Environmental Technology (IEET).
     • Institute for Biotechnology Research.

4.1 JKUAT Research and Innovations

a) The tissue culture bananas
   JKUAT has been a pioneer in Kenya and the East Africa region in the production of tissue culture bananas. The main objective of the innovation was to have rapid propagation of a disease free, faster maturing, high yielding bananas through the tissue culture technology. The innovation involved development of in vitro protocols that would make small tissues of bananas (3 mm in size) multiplied in the laboratories (Figures 1 and 2). Tissue culture propagation is the process of growing tissue culture for plant shoot-tips in a laboratory until they are ready for transplant into the field. About each of the 3 mm tissue would produce 2000 plants in five months. Because of
the highly controlled starter environment, tissue culture propagation significantly reduces disease and dramatically improves yield when coupled with good agronomic practices. These bananas are therefore, more high yielding than the traditional banana varieties that are propagated by transferring banana suckers between farms (Figure 3). The traditional approach increases the risk of transmitting pests and spreading disease among the banana crops.

The tissue cultured banana seedlings are produced at the Universities laboratories and offered for sale. The tissue cultured banana seedlings have been very popular and are sold all over Kenya, and even in Uganda and Tanzania. Apart from sale of ready seedlings from the university, tissue culture banana nurseries are also operated by farmer groups who have been trained at JKUAT. Several farmer groups involved in tissue culture banana nurseries have been established around the country. Each of these farmer groups sell the tissue culture seedlings to their surrounding community. The farmer groups have helped in bringing the tissue culture bananas close to their respective communities hence reducing the cost of obtaining high quality banana seedlings directly from JKUAT.

Figure 1: Tissue culture bananas growing under controlled conditions

Figure 2: Tissue culture bananas seedlings ready for planting
Figure 3: An example of high yielding tissue cultured banana grown by a farmer in Central Kenya.
The project has also resulted in increased banana quality and productivity from 20 to 45 tons per hectare in areas where this technology has been adopted. This has contributed to increased sustainable incomes hence alleviating hunger and poverty. The project is very popular among the farmers. The project has also boosted the quality of the banana produce, hence enabling the farmers to access prime markets. It has also enabled the acquisition of disease-free banana seedlings hence eliminating conventional planting bananas from diseased planting stocks.

b) The Walking Tractor
The Walking Tractor is one of the famous innovations of JKUAT (Figure 1). It is a small tractor with engine capacity of 325 cc (diesel). It therefore utilizes very little fuel. It can be used for transporting farm produce. It is also suitable for small scale ploughing in small to medium scale farms.

![Figure 4: JKUAT walking tractor and tricycle developed in the JKUAT Engineering Workshops](image)

c) ECO Block Making Machine
JKUAT has developed an improved machine for making soil stabilized Eco blocks. It is a manually operated machine that produces between 300 and 400 blocks a day. Tests have shown that the blocks have comparable strength to stone or cement based blocks. They can hence be used to make houses of similar quality as those made from stones or cement made blocks. The house shown in Figure 5 is an example of a house made from these blocks. Yet the blocks are more environmental friendly as they simply involve use of ordinary locally available soil mixed with relatively small quantities of cement. The machines are currently produced in the JKUAT Engineering workshops and are sold at about US$ 800. Several entrepreneurs have purchased them and are now commercially using them to produce Eco blocks for sale.
d) Fruit Pulper

A fruit pulper developed at JKUAT aims to produce juices from fruits. It is power driven by a single phase power. It may produce 300 to 400 litres of juice per day. The machine is also currently produced in the JKUAT Engineering workshops and is offered for sale.

e) Bio shoe polish

Bio shoe polish is an environmentally friendly shoe polish developed from a natural weed that has been a common nuisance to farmers but will now be harvested for shoe polish production. The utilization of the weed in shoe polish production has become both a source of employment, as well as a weed control measure.

4.2. Processed food products

Various innovative food products based on local raw materials have been developed at JKUAT. These include a variety of fruit juices, jam and wine made from local food crops. Such products are unique and are not commercially processed elsewhere. A number of these products have been taken up by private entrepreneurs who commercially manufacture them. Such entrepreneurs are first trained at JKUAT.

4.3. Chemistry products

An assorted range of chemical products are manufactured at JKUAT Chemistry Production Unit. These products include herbal products, toilet soaps, cosmetics, lotions, hair shampoo and conditioner, detergents, disinfectants, paints and wood preservatives. Again all these products are made from locally available materials and are unique to JKUAT. They are not commercially available from any other source. As is the case with the food products, a number of entrepreneurs have taken up the commercial processing of some of these products.

4.6. Dissemination

a) Training in ICT
JKUAT has been identified as a centre of excellence in ICT training. Several organizations have been trained at the university in ICT. These include the Kenya Police.

b) Food analysis
For a long period, JKUAT acted as a regional centre for training in food analysis. Trainees from the countries of East and Southern Africa were trained annually for a period of about one month. The trainees came from Uganda, Tanzania, Burundi, Rwanda, Lesotho, Swaziland, and Botswana. The programme was sponsored by JICA. The programme benefitted from the very good laboratory infrastructure for food analysis at JKUAT. The university also has a very good human resource in the food sciences.

c) Training of women groups in agricultural food production and processing
Women groups from various parts of Kenya have over the years benefitted from training in the skills of agricultural food production and preservation. This training is usually held annually. The training has helped increase the skills of women in food production and processing.

d) Training in mushroom production
Periodic training in mushroom production is held at JKUAT. The trainings are held once every three months. The training provides skills to individuals or groups on the techniques of mushroom production. It also involves imparting entrepreneurship skills to the trainees so that they can run their mushroom production ventures profitably.

4.7. JKUAT Graduates
Currently JKUAT produces about 3,000 graduates per year from the various programmes. Due to its very good reputation of high quality training, most of the graduates are in high demand by employers. The graduates from the ICT and engineering programmes are particularly in very high demand. Graduates from the Departments of Telecommunication and Information Engineering, electrical and electronic engineering do not meet the local demands. A good proportion of the graduates opt to go into self employment. All of them are offered training in entrepreneurship their courses.

Indeed some of the JKUAT alumni have made globally recognized innovations. A remarkable example is the achievement of Mr. Evans Wadongo in his project of Solar-Powered lantern lamps for sustainable development for all-Kenya. The innovation involved production of simple solar powered lanterns that were adapted to be conveniently and cheaply used in the rural areas of Kenya where there is no electricity (Figure 6). This was in recognition of the fact that many rural homes used lantern lamps that used kerosene. Over the years, the cost of kerosene has been rising and many rural households cannot afford it.

Mr Wandago began the solar lantern project while a final year student at JKUAT University in Kenya. While working on his final year project, he realized that the LED lighting could be adapted and used to power the solar lanterns that could be used in many other rural homes. What’s also remarkable is that he used his own money to finance the project and only started getting help
when the innovation gained widespread recognition and acclamation. He has so far distributed over ten thousand lanterns to grateful rural households. His innovation not only reduced the cost of lighting to the rural poor, but it also contributed to a reduction in green house emissions that is associated with use of petroleum fuels.

His efforts, earned him recognition from many including billionaire entrepreneur Sir Richard Branson. Mr. Wadongo was also winner of the CNN World Hero in 2010. He was also one of the three winners of the inaugural Gorbachev awards.

Figure 6: Mr Evans Wadongo, a JKUAT alumnus surrounded by Kenyan rural women using his solar powered lanterns.

**Recommendations**

- Increase funding from government for more research in agricultural technology.
- Support JKUAT to link up with commercial and small farmers in order to increase knowledge sharing between researchers and farmers.
- Facilitate sharing of research results between the university and national agricultural; research institute.
- Support JKUAT to establish science parks and demonstration farms in rural areas.
- Attach public officials dealing with agriculture to JKUAT for short periods so that they can learn from ongoing activities.

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CHAPTER 5

The Creation of Technological Capabilities for Employment Creation in Namibia: The Case of the Polytechnic of Namibia (PoN) By. Mr. Uaripi G. Tjihenuna

5 Introduction

In 1991, the first Presidential Commission on Higher Education in Namibia recommended the creation of the Polytechnic, through the merger of the Technikon Namibia (created in 1985) and the College for Out-of-School Training (COST). The Polytechnic was subsequently established by an Act of Parliament in November 1994 and started operating as an autonomous institution on 1 January 1995. The Polytechnic is the only public polytechnic in Namibia and is one of the fastest growing institutions of higher education in the country. The Act provides for the gradual phasing out of vocational training courses and the granting of degrees by the Polytechnic.

In 1996 the Council formulated its first vision and mission statements for the Polytechnic of Namibia. The first five-year Strategic Plan (1999 – 2003) was approved in November 1999. In 2003 the Council approved a second Strategic Plan (PSP-2). The Polytechnic launched its third strategic planning process in August 2007. The period (2009 to 2013) is regarded by the PoN as critical in order to maintain the momentum gained as it matures into a veritable internationally recognized university of science and technology.

5.1. First Strategic Plan (PSP-1): 1999 – 2003

a) Vision Statement

The Polytechnic of Namibia will be the leading institution that contributes to Namibian development by providing post-secondary education in applied science and technology at internationally recognized standards.

b) Mission Statement

The Polytechnic of Namibia strives to:

- Be a centre of higher learning for the training of high-level, technology-oriented specialists in all priority areas of national development by inculcating the application of knowledge, technology and research results in specific careers and professions;
- Promote the advancement of science and technology through basic and applied research, and to provide facilities appropriate to an academic institution of the highest quality to all
regardless of race, colour, gender, ethnic origin, religion, creed, social and economic status or physical condition;

• Provide all students with the necessary services and facilities and serve both urban and rural communities, and to provide community extension services throughout the country with a view to contributing to the furtherance of the education system as a whole;

• Serve as a repository of knowledge and information for the articulation and development of the Namibian culture and values;

• Safeguard and promote a culture of academic excellence, and the appropriate atmosphere and opportunities for staff, scholars and students in pursuit and realization of high intellectual potential; and

• Promote national and international understanding and cooperation. 

The single dominating impulse that ran through the Vision of PSP-1 was centered on the unprecedented opportunity that the Polytechnic as the then one of only two institutions of higher education in the country needed to contribute to a concerted effort to develop human resource capacity in science and technology. This was perceived against the backdrop of the critical role of the application of science and technology to national development.

The development of the first Polytechnic Strategic Plan (PSP-1) took place at a very difficult period in the history of the institution. The institution was established barely six years after independence after the amalgamation of two other institutions, namely Technikon Namibia (created in 1985) and the College for Out-of-School Training (COST). Resistance to change in institutional culture came as a result of new management under a new Rector. The old system allowed for too much individual freedom and uncontrolled behavior that threatened the order of the institution. It was imperative for the new management to establish a system with a strong sense of responsibility, accountability and success.

The vision formulated by the Polytechnic Council aimed at meeting national human resources needs in an environment that fosters excellence in teaching, learning, research and service. The PSP-1 provided the institution with a framework for achieving this vision, and as such, set the scene for significant changes in academic shape, rigour, methodology and substance. This, in turn, influenced the planned growth in course offerings, services, enrolment and physical infrastructure.

By 2003 the campus had grown four-fold to 12 hectares. Throughout this period, relevance, excellence, affordability and accountability were key benchmarks. As reference points these served the institution well and in combination with the goals became the rallying point for the evolution of the Polytechnic into formidable force in the area of tertiary education in Namibia.

5.2 The Second Strategic Plan (PSP-2): 2004 – 2008
a) Vision
The Polytechnic is Namibia’s internationally recognized University of Applied Science and Technology. This vision clarified the status and profile the institution sought to achieve by 2008. Thus, while it imposed particular assumptions about the core functions, it was also very specific about the organization, the quality and level of education, staffing, type of research, service and infrastructure of the institution. Moreover, it also clearly sought to position the Polytechnic as a global institution.

b) Mission
The Polytechnic contributes to sustainable national development through excellence in technologically-oriented career education and training, applied research and service.

The mission required the institution to support national economic development through high quality programmes, technology-based teaching, innovative research and community service. New and enhanced qualifications would provide the technological skills necessary for students and graduates to work successfully in the global marketplace. In addition, the Polytechnic’s faculty was expected to contribute to new knowledge that would improve the quality of life for Namibians.

c) Third Strategic Plan (PSP-3): 2009 - 2013
PSP-3 was developed through a process of extensive internal and external consultation. While seeking to be a comprehensive university, the Strategic Plan identifies a focus on niche areas where the potential exists to make a lasting and unique impact on national and regional development. The Polytechnic of Namibia’s Third Strategic Plan (PSP-3) 2009 – 2013 sets out the following Vision Statement, Mission Statement, Values, and Goals for the institution:

d) Vision
The vision in the second plan was to be a premier university of science and technology educating leaders for the new economy. This vision as contained in the third Strategic Plan (PSP-3) aims at promoting national competitiveness by providing multiple opportunities for excellent education, applied research, innovation and service in order to improve the Namibian economy and society as a whole

e) Mission
To promote national competitiveness by providing multiple opportunities for excellent education, applied research, innovation and service.
f) Values

- **Excellence:** To strive for the highest quality in all its programmes, services and activities.
- **Inventiveness:** To recognize innovative and creative thinking, and value the impact of each member of the Polytechnic community.
- **Inclusiveness:** To value the contribution of each community member and subscribe to teamwork, joint responsibility and ownership.
- **Transparency:** To expect responsibility and accountability from each community member and value open decision-making process.
- **Integrity:** To value each member of the Polytechnic community and support honesty, dedication, professionalism and the fair treatment of all.

5.3 Goals and their Implementation

The vision of the Polytechnic as encapsulated in PSP-3 is undergirded by the following goals:

a) **Excellent Programmes:** offering internationally accredited qualifications, incorporating applied research and community service aimed at meeting the needs of the workforce.

The institution offers 67 Programmes leading to more than 110 qualifications. All programme development activities are guided by an approved Curriculum Framework. The Curriculum Framework also guides the review and re-carriculation of all existing programmes in order to ensure alignment with requirements of the National Qualification Framework (NQF).vi

In addition, the institution has introduced a curriculum model to guide the development of undergraduate programmes, including competencies in Computer User Skills, English Communication, Information Competence, Basic Mathematics, Basic Science and Contemporary Issues. The development of all PoN programmes involves active participation of industry and other relevant stakeholders, nationally and internationally. Hence, the process that guides programmes (curriculum) development and approval are outlined in the curriculum framework and adherence is constantly monitored.

Presently, out of the 45 qualifications submitted to the NQA for NQA registration, twenty-five (25) are registered while another eight (8) qualifications received NQF compliance check reports as at October 2011.

The statistics of NQF registered qualifications are not yet at the expected level given the fact that the institution currently offers 67 programmes leading to more than 110 qualifications. However, the capacity to innovate upon pre-NQF programmes and align resultant qualifications within the various departments is a pertinent challenge. The institution plans to revisit the workload of staff
that is responsible for curriculum development in order to ensure that they can devote sufficient
time to curriculum development activities. Alternatively, the institution considers appointing
additional staff to strengthen the capacity in curriculum development at departmental level.

The newly established Directorate for Programme Development and Registration regularly
conducts workshops to ensure that academic staff are familiar with the requirements of the
Curriculum Framework and updated with the latest developments in curriculum design and the
National Qualifications Framework.

To ensure that programmes have excellent quality, the Polytechnic incorporates the practice and
technologies relevant to the respective professions as well as research projects, community
service, work-integrated learning and professional certification. Programmes and resultant
qualifications meet national development priorities, are demand-driven, career-oriented and
developed in close partnership with communities and the public and private sectors.

The Polytechnic of Namibia also has a number of internationally accredited programmes such as
the Master of International Business (MIB) which is accredited to the Foundation of International
Business Administration Accreditation (FIBAA) and CISCO. Furthermore, the School of Engineering
is in the process of acquiring accreditation from the Engineering Council of South Africa (in
consultation with the Engineering Council of Namibia) while the Department of Architecture is
planning to launch its accreditation with the Namibia Council of Architects and Quantity
Surveyors (NCAQS). Programme Accreditation at institutional level is guided by the Accreditation
Guidelines.

**b) A Student-Centered University - developing a dynamic environment that
nurturesthe students' desire for generation, acquisition and application of
knowledge and skills, professional success and service to society.**

Tuition is provided across the six Schools and qualifications offer multiple exit points at
Certificate, Diploma, Bachelors, Honours degree levels and Masters programmes. Some
programmes are offered through the CED and the Office of the Registrar. Tuition is provided in
different modes, i.e. face-to-face, part-time, distance, and e-learning. Through the Center for
Lifelong Learning (COLL), the institution provides distance education and e-learning opportunities
to students through ten (10) centers all over the country.

In 2010 COLL won the prestigious Commonwealth of Learning Award of Excellence for
Institutional Achievement in Distance Education and the School of Communication, Criminal
Justice and Legal Studies is a UNESCO Center of Excellence in the provision of Journalism
Education since 2009.
Through the Office of the Dean of Students, the institution provides excellent services that are designated to contribute to the health, social, academic, career, sports, cultural, moral, intellectual, and physical well-being of students. These services help students gain self-confidence and sense of community. Through the Student Representative Council, students participate in all decision-making structures in order to ensure that the needs of the students are taken care of.

c) A Positive Working Environment – attracting and retaining a critical mass of highly qualified staff, and creating a conducive and stimulating working environment.
   - The requirement for appointment of faculty is a Master’s degree in a relevant field;
   - All academic staff is on a cost to company package which has improved the conditions of service for academic staff; an
   - A draft staff development policy exists at the institution and should enhance opportunities for further studies for all staff.

d) A Modern Infrastructure – creating a dynamic and robust infrastructure to support student-centeredness, facilitate effective teaching and learning, and instill a sense of pride in faculty, staff, students and alumni.
   - The institution boasts of state-of-the art facilities and infrastructure in most of the schools (e.g. the new Science and Technology Building, the Engineering Building). Most classrooms have smart boards.
   - The library is one of the biggest and well-resourced libraries in the country.

e) Effective Strategic Governance and Management – working closely with the Council, the campus community, alumni, and external stakeholders to set strategic direction, develop policies and procedures and generate the resources necessary to give effect to the mission.

Through the Council committees there is a strong working relationship among Management, Council and SRC.

The periods marking PSP-2 (2004 – 2008) and PSP-3 (2009 – 2013) were characterized by a special focus on changing the name of the institution from a polytechnic to a modern university of science and technology. While many argue that there is overwhelming evidence that the institution would meet international criteria of a modern university of its kind (in terms of essential qualities of a university e.g. its faculty profile, qualifications profile and international ranking and accolades achieved over the years), national priorities, have recently taken precedence and the institution has remained a polytechnic in name until a comprehensive review on higher education has been undertaken by the Government of Namibia.
5.4 Enrolments and Graduation Figures (2002 – 2011)

The statistics captured in Annexure A show the total enrolment figures over a period of ten years (from 2002 to 2011). However, the enrolment statistics given in the tables in the Annexure (B to H) were recorded on April 30th during the years 2005 through 2009. Demographic data is linked to information recorded on the ITS system at the time of registration. These enrolment figures do not include registration that was cancelled before the census date of April for the respective year or those registered after 30th April. Therefore semester 2 additions are not represented in these tables (B –H). Equally too, most of the statistics covered in the tables at the Annexure cover the period mainly between 2005 and 2009. However, the figures given below provide a synopsis covering the period 2002 – 2011 for both enrolments and graduation.

a) Enrolments

A total of 5 632 applications for admission were received in 2002 and only 1 918 new students enrolled. A total of 4290 students were registered, of which (52%) were female and about 45% of the student population was in the new students’ class. The new intake constituted 34% of the total number of applications and a 12% increase in admissions from the previous year.\textsuperscript{x}

About 2822 students enrolled in the School of Business and Management, 766 in the School of Engineering and Information Technology, 474 in the School of Natural Resources and Tourism and 147 in the School of Communication, Legal and Secretarial Studies.

Approximately 7200 new applications were received for the 2003 academic year. This represented an increase of 8% in applications compared to 2002. However, only 1 792 new students were admitted. A total of 4 647 students registered, representing an increase of 6.5% in enrolment from the previous year. The overall ratio of male to female was 49%:51\textsuperscript{x}.

The School of Business and Management remained the biggest with 66.5% of student enrolment followed by the School of Engineering and Information Technology at 17%. The School of Natural Resources represented 9.2% of the total student enrolment, while the School of Communication, Legal and Secretarial Studies only represented 7.3% of the total student enrolment.\textsuperscript{x}

Two thousand three hundred and five (2 305) students were enrolled in the full-time mode, with about 1 494 in the part-time and 848 in the distance modes, respectively.\textsuperscript{xi} A total of 4 739 students registered at the Polytechnic in 2004 in different fields.
From 2004 to 2005 enrolment increased from 4,739 to 6,075 which constituted a 20% increase, a significant milestone revealing the institution's appeal to the public. In 2006 about 7,000 students were registered, compared to 5,066 in 2005, representing an increase of 38%.

A total of 8,292 students registered at the Polytechnic for the 2007 Academic Year. Out of that total, 4,191 were full-time students, 2,325 were part-time and 1,671 were distance students. As usual, the majority of the full-time students (5,678) registered in the School of Business and Management. The same pattern can be observed in both the part-time and distance students. Out the total students registered for that year, 54% were female as compared to 46% male.

Out of 11,548 applicants, only 3,501 new students could be registered because of lack of space. A total of 9,301 students registered for the 2008 Academic Year. Out of that total, 34 (0.36%) students registered for Master's programmes, 7,998 (85%) for degree programmes, 938 (9.97%) for diplomas, 148 (.57%) students registered for certificate qualifications, 178 (1.89%) registered for introductory certificates and 114 (1.21%) registered for other non-degree programmes.

A total of 11,531 students registered for the 2010 Academic Year and out of that total 6,422 (55.69%) were female and 5,109 (44.31%) were male. Out of that total 93 students registered for Master's programmes, 131 for Honours degrees and 10,102 registered for BA degree programmes. The rest registered for diplomas and certificates. About 53% of the students registered for full-time studies, 26% were par-time and 21% were distance students.

The statistics in Annexure (B – H) deal with enrolment per Faculty, enrolment by gender, enrolment per offering type, enrolment by qualification type, enrolment by qualification type and faculty, undergraduate enrolment by period of study per faculty and postgraduate enrolment by period of study respectively.

These statistics show that the School of Business and Management represents more than 70% of all enrolments, that the ratio of female to male students is about 56:44 (on average), that there are about 50% full time students, 30% part time and about 20% distance students, that the enrolment for Bachelor's degrees and Master's degrees has increased over the years while enrolment for diploma and certificate qualifications has decreased over the years – thus making a strong case for the institution to be given a university status.

b) Graduation

At its seventh graduation ceremony held on 8 April 2002, the Polytechnic awarded 881 qualifications: 327 National Certificates, 57 National Higher Certificates, 494 National Diplomas and three (3) Bachelor's Degrees.
At its 8th Graduation Ceremony held on 12 April 2003, the Polytechnic conferred a total of 956 qualifications: 346 National Certificates, 105 Higher Certificates, 469 National Diplomas and 36 Bachelor Degrees. Fifty three percent (53%) of the graduates were women compared to only forty seven percent (47%) men. xvii

Fifty six (56) Bachelor’s degrees, 445 National Diplomas, 97 National Higher Certificates and 340 National Certificates were conferred in 2004. Thus altogether 938 qualifications were awarded.

At the 10th Graduation Ceremony of 2005, more than 1 166 students received qualifications. One hundred and forty six (146) Bachelor’s degrees were awarded in fields such as Business Administration, Human Resources Management, Mechanical Engineering and Information Technology for the first time. xviii

At the Eleventh Graduation Ceremony held in April 2006, 1 149 students received qualifications, including 147 Bachelor’s degrees, the latter representing an increase of more than 16% on the previous year. Of note is the increase in the output of Diploma and Degree holders in engineering, science and technology by more than 800% in the last ten years, thus contributing to the much-needed technically qualified professionals in the national economy. xix

A total of 2202 students graduated from the Polytechnic in 2010 and out of that, 1209 were female and 993 were female. Out of that total, only one student graduated with a Master’s degree, 43 were awarded Honours degrees, 594 were awarded first degrees (B Techs and Bachelor), 693 received diplomas, 76 received Higher Certificates and 875 were awarded Certificates. xx At the 16th Graduation Ceremony of the Polytechnic in 2011, altogether 1 793 students graduated in different disciplines. Out of that total 246 were female and 223 were male.

Again, Annexure I and J indicate that the School of Business and Management produces the biggest number of graduates - 64% in 2008, for example. These statistics also show that the number of Bachelor degree graduates has increased while the number of the students graduating in diploma and certificate qualifications has almost remained constant, and in fact in some cases it has decreased.

5.5 Approach to Quality Assurance

The Polytechnic has long moved from the traditional approach of quality assurance which regarded the external examiners system of being the only approach towards institutional quality management and has embraced a model which regards institutional quality management as a function that resides in the management of the institutional systems and processes and therefore being the responsibility of all management.
In 2003, the Polytechnic established its first Quality Assurance Office in the Office of the Registrar. This Office set the framework for institutional quality assurance. This development was followed by the Polytechnic signing of an agreement with the High Education Quality Council (HEQC) of South Africa for the provision of external quality assurance to the institution through audits and programme accreditation in 2004. In 2007, the PoN became the first higher education institution in Africa to be audited by the HEQC together with South African universities.\textsuperscript{xxi}

During September 2007, an independent Quality Assurance Office was established in the Office of the Rector. The mandate of the Unit is the coordination of the quality management function of the institution. The mandate of the Unit is the coordination of the quality management function of the institution. The intended purpose of the QA Unit is to ensure that all students at the Polytechnic of Namibia are able to realize their potential in a quality assured learning environment and achieve qualifications whose quality is benchmarked with reputable regional and international programmes. However, the scope and operations of the quality assurance activities are largely defined by both the Namibia Qualifications Authority and the Higher Education Acts – e.g. the alignment of all programmes to the National Qualifications Framework (NQF) strongly influences the quality of programmes being offered.\textsuperscript{xxii}

Following the approval by Senate of the Quality Assurance Policy for the Polytechnic in June 2009, an Institutional Quality Assurance Committee (QAC) was established at the Polytechnic in May 2010. The QAC is responsible for ensuring that the Polytechnic has a rigorous and responsive quality assurance framework in place and responds to Council through Senate.

5.6 Pilot Audit of the National Council for Higher Education (NCHE)

During 2009 the NCHE developed a national quality assurance system consisting of two sub-systems, i.e. programme accreditation and institutional audit. In June 2010, the NCHE requested to pilot the institutional audit sub-system with the Polytechnic of Namibia. The programme accreditation sub-system was to be piloted with the University of Namibia. Recognizing the importance of achieving national credibility and promoting its identity, the Polytechnic agreed to participate in the pilot audit through self-evaluation. The project was to be spearheaded by the Quality Assurance Office.

While preparing this self-evaluation, the Polytechnic took into account the focus of the pilot audit as agreed with the NCHE. In terms of an agreement between the two institutions, the scope of the pilot audit was limited to Theme 1 of the Criteria of Institutional Audit published by the NCHE in 2010. Theme 1 focuses on the following institutional processes:

- General Management Processes;
- Systems for managing quality;
The QA Office commenced the process of preparation by familiarizing itself with the NCHE Criteria for Institutional Audit. Subsequently, all senior management was interviewed to source their inputs into the self-evaluation report and the whole Polytechnic Community was also informed. With several consultative meetings between the NCHE and QA Unit of the Polytechnic, the Self-Evaluation process commenced on 14 March 2011 and was concluded in July 2011. The institution was guided by the NCHE institutional audit criteria. The institution was basically required to report on the effectiveness of its general management and institutional goals.

The audit portfolio report that was subsequently produced was compiled primarily through a review of already published information by the institution as well as on the basis of data and views of institutional members obtained through face-to-face interviews conducted during May 2011.

5.7 International Partnerships and Accreditation

The Polytechnic has partnerships with universities in Austria, Australia, Botswana, Czech Republic, Finland, Germany, Italy, Mozambique, Norway, The Netherlands, South Africa, Sweden, Thailand, United Kingdom, and the United States of America. The partnerships focus on joint curriculum development, joint offering of qualifications, faculty and student exchanges, and research.

The Polytechnic of Namibia is accredited to the following institutions:

- Higher Education Quality Committee (South Africa);
- Foundation of International Business Administration Accreditation (FIBAA) (Europe); and
- The Namibia Qualifications Authority (NQA).

Apart from these international partnerships and accreditation, the number of awards that the institution has achieved over the years is an attestation of the extent to which the institution is achieving its vision and mission. The Polytechnic of Namibia has, over the years, scooped the following awards:

- Public Management Review (PMR) Golden Arrow Awards as the best Higher Education Institution in the country (2003 – 2009);
- PMR Diamond Award (2010);
- CISCO Global Recognition Award (2007);
- UNESCO Centre of Excellence (2007);
• UNEVOC Centre Award (2007) – furthering UNESCO goals in the areas of Technical and Vocational Education and Training;
• CISCO Top Local Academy Namibia (2009) – use of ESRIS Geographic Information System (GIS) technology;
• EDUNIVERAL Palms (2009) – amongst 1 000 best Business Schools in the world;
• Special Achievements in GIS Award (2009);
• Sam Nujoma Award (SNIEDA); and
• Women in Engineering Award (WIE) (2009).

5.8 Centers of Excellence

The Polytechnic’s efforts to address strategic initiatives focus on the development of institutional Centers of Competence that build staff capacity and enhance core competencies. These Centers sustain the institutional transformation evident in the Polytechnic’s success over the past few years. The institution runs the following Centers of Excellence:

• Namibia Business Innovation Centre (NBIC);
• Namibia-German Logistics Centre (NGLC);
• Renewable Energy and Energy Efficiency Institute (REEEI)
• Center for Open and Lifelong Learning (COLL);
• Centre for Entrepreneurial Development (CED);
• Center for Teaching and Learning (CTL);
• Integrated Land Management Institute (ILMI); and
• Center for Cooperative Education (CCE).

5.8.1 The Namibia Business Innovation Center (NBIC)

The NBIC has four core pillars:

• Innovation Programmes are designed to motivate entrepreneurs, help them find partners and create business ideas.
• Research and Development Programmes foster partnerships between established companies and Namibia’s academic institutions as well as start-up companies.
• Entrepreneurship Programmes that support entrepreneurs from the idea to the growth phase of a new business, through mentoring and incubator services.
• Education and Training Programmes that complement the existing curricula of traditional education and training providers by filling the gaps of entrepreneurs and also
managers in established companies through condensed, hands on training covering the essentials in building and running a business.

5.8.2 Namibia-German Centre for Logistics (NGCL)

The NGCL was officially opened in May 2009 and it is a cooperative project between the Polytechnic of Namibia and Flensburg University of Applied Sciences, Germany. NGCL addresses the very challenges which are intrinsic to the management of the flow of goods, information and other resources between producers and consumers in Namibia and within SADC in general.

The center facilitates the offering of scholarships for Honours through liaising with companies such as Roads Authority. The greatest challenge is the lack of staff with relevant qualifications in logistics to teach. The insufficient knowledge about logistics, and supply chain management in the country poses further challenges, such as the struggle to get suitably qualified staff for this field. It is rare to find a person with PhD in logistics in Namibia or even in SADC.

5.8.3 Renewable Energy and Energy Efficiency Institute (REEEI)

REEEI is a national institution at the Polytechnic of Namibia founded in 2006 through a cooperation agreement with the Ministry of Mines and Energy. The institute was established as a national information resource base for renewable energy and sustainable energy use and management. Its mandate, which is largely derived from that cooperation agreement, is to:

- Facilitate and conduct research into renewable energy and energy efficiency;
- Develop materials and standards, reports and disseminate information and materials on renewable energy (RE) and energy efficiency (EE); and
- Facilitate cooperation between MME and the Polytechnic, as a public institution, primarily responsible for RE and EE as well as other stakeholders.

The institute has become Namibia’s first information dissemination platform in its field and now plays a leadership role in the transformation of knowledge from traditional energy sources and usage to a more sustainable energy economy. REEEI works closely with the Ministry of Mines and Energy and steps are afoot to transform it into the Energy Institute to give it a wide-ranging mandate in order to help address all energy needs in the country.

5.8.4 Center for Open and Lifelong Learning (COLL)

It was established in 1995 and serves a broad profile of students. Many students come from the capital (Windhoek area) and are taking classes by distance education mode because it allows them to study while maintaining their employment and continuing their family responsibilities. Other students are from rural areas where they may not have easy access to learning resources.
COLL recently won the Commonwealth of Learning, Award of Excellence for Institutional Achievement in Distance Education provision for 2010. It runs ten (10) Regional Centers spread across the country.

5.8.5 Center for Entrepreneurial Development (CED)

The center was established in 2000. The CED is the industrial skills development and training arm of the Polytechnic of Namibia. The center has grown into a local powerhouse for extracurricular training in Namibia. The centre has six (6) units, namely:

- Short Courses
- Institutional and Corporate Training
- ICT Academy
- SME Development and Support
- Seminars and Conferences
- Consulting and Technical Services

5.8.6 Centre for Teaching and Learning (CTL)

CTL was established in 2000. The overall mandate of CTL is to provide professional academic support services to faculty and students. The centre has three core areas: Professional Development, Academic Support and Students E-Learning. One of the visible achievements of CTL is the facilitation of an annual workshop entitled “Great Teachers’ Workshop” for lecturers during the June recess. The biggest challenge facing the centre is the insufficiency of resources and lack of time for lecturers to conduct research. The quality of the lecturers is very hard to assess because they teach more than 18 hours per week. They do not seem to have enough time to do preparation, research or even time to attend to their own students.

5.8.7 The Integrated Land Management Institute (ILMI)

ILMI was launched at the end of May 2008. It is a multi-disciplinary research and consulting centre specializing in the field of integrated land management. Its expertise covers a wide range of land and natural resources sectors, with particular expertise in land administration, land reform and resettlement, land use planning, land valuation and estate management and agricultural lands management, nature conservation and tourism resource management, with particular insight in surveying, mapping, land registration, urban and rural planning, environmental management, and the use of participatory methodologies for research and data collection.28v

5.8.8 Center for Cooperative Education (CCE)
Given the relatively low graduate’s employability rate in the country, CCE was established in 2010 to facilitate cooperation between the Polytechnic, industry, commerce and the public sector to enhance learning, which includes work-based, and service training, liaison with industry, partnerships, research, and development as well as the formation of advisory committees. In other words, CEE coordinates Work Integrated Learning (WIL) opportunities for Polytechnic students. Students gain experience from WIL to increase their chances for employability.

5.9 Tracer Study of Graduates from Higher Education Institutions 1999 – 2008

The Education and Training Sector Improvement Programme (ETSIP) aims at increasing the supply of middle and higher level skills to the Namibian society, so as to bring about more rapid economic growth and contribute to the attainment of Vision 2030.

It was against this backdrop that the National Council for Higher Education commissioned a tracer study of graduates from the University of Namibia and the Polytechnic of Namibia (both public institutions) who completed their studies in the years 1999 – 2008. The terms of reference required that the consultancy report should:

- Contain a detailed review of the economic and employment status (or otherwise) of graduates from Higher Education institutions across various academic disciplines and in various institutions.
- Provide a clear and unbiased picture of the assessment of graduates by their employers in respect of various categories such as their scholarly abilities, their abilities to apply theoretical knowledge to concrete problems, their ability to generate and disseminate knowledge and their competitiveness measured against graduates and non-degree holders from other education providers in the country and beyond.
- Provide an in-depth assessment of how graduates assess themselves and the relevance and quality of their education within the world of work.
- Based on the tracer study, suggest ways of improving inter-institutional collaboration in education and training.
- Develop an instrument for future impact assessments.
- Avail the data used in the study so that it may be used in future research.

The views of employers of graduates were also to be ascertained, particularly concerning graduates' scholarly abilities, their abilities to apply theoretical knowledge to concrete problems, their abilities to generate and disseminate knowledge and their competitiveness measured against graduates and non-degree holders from other education providers in the country and beyond.
An attempt was made to interview a broad spectrum of employers. In this regard, larger Ministries of economic significance were chosen. The Employers Federation and the Namibia Chamber of Commerce and Industry were consulted about suitable interviewees in the Private Sector. Although most employers are based in Windhoek (even when they have branches in the Regions), employers in Caprivi, Erongo, hardap, Karas, and Oshana Regions were also interviewed.

The following indicates the nature of the employers interviewed:

- Regional Councils: Caprivi (Education and Agriculture) Hardap (Health), Karas (Health, Finance).
- Local Authorities: Swakopmund, and Walvis Bay.
- State owned organizations: Transnamib, and Nampower.

Private Sector Companies engaged in the fields of: Agriculture, Banking, engineering, Financial Services, Fishing, Health, ICT and Telecommunications, Tourism, Manufacturing, Mining, and Retailing.

Altogether 850 questionnaires were sent to respondents, and of the total questionnaires returned, only 259 (139 from UNAM graduates and 108 from PoN graduates, and 12 from graduates from both institutions) proved to be useable. Forty-three (43) employers were interviewed in both public and private sectors.

The profile of those graduates who completed the questionnaire was found to be similar to that of the graduates in the Namibia Labour Survey 2008, in terms of the industries that people are working in.

5.9.1 Findings

The following are some of main findings of the tracer study of graduates:

- The decision to study at a particular institution is strongly influenced by the reputation of the institution, and to a lesser extent by the availability of a practice-oriented study programme.
- Most graduates contacted up to three employers before their first employment. This number seems rather low, considering that graduates would presumably want to
maximize their choices. However, 23% of UNAM graduates, compared to 15% of PoN graduates contacted only one employer before finding employment. The field of study and area of specialization were felt to be the most important factors in obtaining employment.

- More than 60% of graduates receive on-the-job training.
- Nearly 60% of graduates had not changed their employer since graduation. Roughly about 78% of UNAM graduates, 70% of PoN graduates, and 92% of those who hold qualifications from both institutions, work for a public employer (including local authorities). Only 1% of graduates are self-employed.
- Nearly 60% of PoN graduates are employed in the Khomas Region compared to 35% of UNAM graduates.
- About 11.7% of UNAM graduates and 14.4% of PoN graduates are unemployed and seeking employment. This is a cause for concern, taking into account the enormous public and private investment in a graduate. Similarly, the 2008 Labour Force Survey found that 10.2% of people with a first university degree were unemployed.
- There is a tendency for the monthly earnings of UNAM graduates to be slightly higher than those of PoN graduates.
- Most graduates feel that they have been able to realize the career that they expected at the time of graduation, that they are using the skills acquired during their studies, and that their position and status is appropriate for their level of education. However, more than 60% of PoN graduates have taken up work not linked to their studies. About 27% said that they could not find a job closely linked to their studies, while 24% felt that they had better career prospects in their current job.

5.9.2 From the interviews with employers

The views expressed by those interviewed are not necessarily those of all employers. The following appear to be the major findings flowing from the interviews of employers:

- Employers do see benefits from the employment of graduates. They value most highly the commitment of graduates to their employer, their willingness to learn, their self-confidence, subject knowledge, their ability to make suggestions for improvement, and their professionalism.

However, some employers feel that that the graduates are not adequately prepared for work. They are seen to lack experience of the workplace. They might not have realistic expectations of their contribution or prospects. Internship, insofar as they exist, may not always be adequate preparation for work. The tracer study also shows that employers are providing a lot of on-the-job training.
• Most employers are apparently not satisfied with the level of written English of graduates. In part, this may relate to the level of English with which students enter higher education. However, it still reflects poorly on the standards of writing, reading and argument that are demanded at the higher education institutions.

• According to employers, most graduates are interested in further studies, a tendency that they are willing to support financially and other ways. However, there are doubts about whether students are seeking promotion, through possession of a paper qualification, or improved knowledge and performance.

• It feels that a significant proportion of employers do not feel that they have sufficient in-depth contact with institutions of higher learning, although some satisfactory relationships do exist. Where a dialogue is inadequate, there is a measure for frustration among employers who would like to play a constructive role by making their views known and providing feedback on how graduates are doing.

• It seems higher education institutions are doing little research in collaboration with employers.

5.10 Conclusions

The Polytechnic commenced with operations as an autonomous institution in 1996 with a student enrolment of 2,500, 73 administrative staff and 69 lecturers with premises covering about 3.0 hectares. As at 25 October 2011 it had 325 full-time faculty, 261 part-time lecturers and 311 administrative staff. Again as at 30 September 2011, the student population stood at 12,440, which is almost six times higher than the 1996 figure of 2,500. This implies that between 1996 and 2011 the student population has grown by about 600%.

The institution inherited area of 3 hectares in 1996 and throughout the years it has expanded to cover some 14 hectares. However, this area is still far too small given the increase in the student population and the expansion in academic offerings.

The current (2011) student enrolment is about 12,440 students. Approximately 50% of students enrolled are fulltime, while 25% are part-time and 20% distance students. Tuition is provided through a mixture of face-to-face, e-learning and distance education. In 2010 55% of students were female as compared to 44% male, and the proportion has steadily increased since 2000.

The biggest school is the School of Business and Management which accounts to close to 70% of the student population and the average ratio of female to male students is about 44%:46%. This means that over the years the majority of the Polytechnic students have been female. The number of degrees awarded has increased over the years justifying the argument for the institution to be accorded a university status.
Some of the biggest challenges facing the Polytechnic are inadequate subsidy from Government, the lack of recognition as a university of science and technology, overload of lecturers who at times end up lecturing 18 hours a week – thus not allowing them enough time to do research and to attend to their students - and the astronomical growth in the student population which is disproportionate to the size of the of the land and the facilities at the disposal of the institution. The growth has reached a point where the Polytechnic has been obliged to temporarily cap numbers to ensure that the appropriate quality standards are maintained. This has implications for a developing economy with a high demand for medium through to high level technical, scientific and management skills in an ever-expanding technological environment.

Another and related challenge is the shortage of space across all areas. While the institution is managing the shortfall through efficient timetabling, extended teaching hours and flexible use of space, it ultimately has implications for quality. The NCHE Audit identifies a shortage of space not only for teaching but also for some administrative functions such as keeping student records and scheduling of examinations. This seems to pose some quality risk areas for the institution.

Research is primarily conducted within the Schools. Currently approximately 70% of the faculty is engaged in research. The establishment of the Centers such as NBIC, CART, and REEE as well as the implementation of graduate degrees will further stimulate a culture of research.

The lack of a university status has a number of disadvantages for the Polytechnic which are as follows:

- Some of the international partners are reluctant to partner with an institution which does not have a university status;

- Polytechnic graduates may face challenges in having their qualifications recognized internationally, for example if they want to further their studies outside Namibia; and

- Academics who have ambitions to become Professors cannot acquire that status while lecturing at a polytechnic.

The shrinking and ever decreasing or sometimes unstable government funding experienced by most African higher education institutions is real challenge to the Polytechnic of Namibia as well. The institution is working hard to address the higher education needs of the country in order to contribute to Vision 2030; however, the funding has always been a challenge. The instability of funding from government hampers institutional effectiveness in many ways, e.g. the institution is never certain about when the subsidy will be available.

Staff overload is also a challenge e.g. academic staff end up teaching more than 18 hours in some of the programmes and this obviously affects quality. The issue of staff overload is directly linked
to the problem of under-funding. The other challenge is insufficient facilities that can accommodate the growing number of students. According to the Polytechnic’s own projections, the institution was planning to reach an enrolment figure of 12 000 students by the 2015.\textsuperscript{xxxii} This figure has been reached during the 2011 Academic Year, while the space has not expanded much. Physical space is becoming a challenge, e.g. there is limited space for keeping the student records and examination venues are not sufficient.

According to the ongoing study by NCHE, while most graduates feel they are using the knowledge and skills acquired during their studies, it is, however, worth noting that a large number of the Polytechnic’s graduates (60%) have taken up jobs that are not linked to their fields of study. This can be interpreted in different ways, either the Polytechnic is training students in areas that are not in demand in industry or it might mean that the institution provides a flexible curricula that enables students to apply their knowledge in whatever area they find themselves in.

Almost 80% of the graduates obtained jobs in the second year after graduation and most of them got their first job after contacting about three employers. This seems to be a long waiting period, especially taking into account that there is an acute shortage of high level skills in the country. All stakeholders like the public and private sectors as well as higher education institutions need to urgently attend to this problem so as to ensure a speedy absorption of graduates into the job market.

Both the Labour Survey of 2008 and the ongoing Tracer Study indicate that about 10% of graduates are unemployed and only 1% of the graduates are self-employed. This poses a great challenge to the institution both in terms of producing graduates that are absorbed into the job market and also in terms of preparing students to become self-employed. This cannot be achieved unless the institution begins to produce graduates who are strongly grounded in innovation and entrepreneurship. To be able to achieve this, the institution will have to revise its curriculum; however, strong financial and legal frameworks need to be put in place to enhance self-employment and the development of the SME sector.

Some of the positive comments from the employers about certain attributes of the graduates are as follows: commitment to their employers; willingness to learn; self-confidence; professionalism; good subject knowledge; and ability to suggest improvements. Much as these are welcome there is, however, a view that the graduates are not adequately prepared for work and hence the need for employers to provide a lot of on-the-job training.

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<tr>
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<tr>
<td>2005</td>
<td>5 986</td>
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<tr>
<td>2006</td>
<td>7 396</td>
</tr>
<tr>
<td>2007</td>
<td>8 292</td>
</tr>
<tr>
<td>2008</td>
<td>9 410</td>
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<tr>
<td>2009</td>
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<tr>
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<td>2011</td>
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<td>%</td>
<td>Num</td>
<td>%</td>
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## Annexure C: Enrollment by gender

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<td>2007</td>
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## Annexure D: Enrollment per Offering Type

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## Annexure E: Enrollment by Qualification Type

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Annexure F: Enrollment by Qualification Type and Faculty
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Annexure G: Undergraduate Enrollment by Period of Study per Faculty
| School of Communication, Legal & Secretarial Studies |  |
|---|---|---|---|
| 2nd year | 108 | 105 | 128 |
| 3rd year | 127 | 180 | 133 |
| 4th year |  |  | 40 |

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### Annexure H: Postgraduate Enrollment by Period of Study per Faculty

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</tr>
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<td>School of Information Technology</td>
<td>Masters (5th Year)</td>
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<td>12</td>
<td>10</td>
</tr>
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<td>School of Natural Recourses &amp; Tourism</td>
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### Annexure I: Graduation Summary by Faculty for all Award Types

<table>
<thead>
<tr>
<th>Faculty</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
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<tbody>
<tr>
<td>Enrolments</td>
<td>Graduates</td>
<td>%</td>
<td>Enrolments</td>
<td>Graduates</td>
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<tr>
<td>Business &amp; Management</td>
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<td>693</td>
<td>59.3%</td>
<td>4959</td>
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<td>Communications</td>
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<table>
<thead>
<tr>
<th>Faculty</th>
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<th>2007</th>
<th>2008</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Awarded Grads</td>
<td>%</td>
<td>Awarded Grads</td>
<td>%</td>
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<tr>
<td>Business &amp; Management</td>
<td>Degree 118</td>
<td>10.1%</td>
<td>201</td>
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</tr>
<tr>
<td></td>
<td>Diploma 297</td>
<td>25.4%</td>
<td>342</td>
<td>22.9%</td>
</tr>
<tr>
<td></td>
<td>Higher Certificate 26</td>
<td>2.2%</td>
<td>8</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>Certificate 252</td>
<td>21.6%</td>
<td>264</td>
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<tr>
<td>Course</td>
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<td>36%</td>
<td>53</td>
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<td>-----------------------------</td>
<td>---------</td>
<td>-----</td>
<td>----</td>
<td>------</td>
</tr>
<tr>
<td>Communications, Legal &amp; Sec. Studies</td>
<td>Higher Certificate</td>
<td>8</td>
<td>0.7</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Certificate</td>
<td>26</td>
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<td>53</td>
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<td>93</td>
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<td></td>
<td>Degree</td>
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<td>0.6%</td>
<td>23</td>
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<td></td>
<td>Diploma</td>
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<td></td>
<td>Certificate</td>
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<td>0.9%</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Diploma</td>
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<td>89</td>
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<td>2008</td>
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<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Master</td>
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<td>2</td>
<td>2</td>
<td>4</td>
</tr>
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<td>Honours</td>
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<td></td>
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</tr>
<tr>
<td>Bachelor</td>
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<td>17</td>
<td>18</td>
<td>27</td>
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<td>National Higher Certificate</td>
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<td>6</td>
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<td>National Certificate</td>
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<td>23</td>
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<tr>
<td>Post-Graduate Certificate</td>
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<tr>
<td>Total</td>
<td>66</td>
<td>72</td>
<td>73</td>
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**Source:** Polytechnic of Namibia, Audit Portfolio Report, June 2011.

### Annexure L: Student Staff Ratio

<table>
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<tr>
<th>Faculty</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
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<tr>
<td>-------------------------------------</td>
<td>--------------</td>
<td>------</td>
<td>------</td>
<td>---------------------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>UNAM</td>
<td>PoN</td>
<td>Both UNAM and PoN</td>
<td>University</td>
<td>Post Grad Degree</td>
</tr>
<tr>
<td>Agriculture, Forestry</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>50</td>
<td>0.7</td>
</tr>
<tr>
<td>Fishing</td>
<td>0</td>
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<td>0</td>
<td>0.0</td>
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<tr>
<td>Mining and Quarrying</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>2.4</td>
<td>5.5</td>
</tr>
<tr>
<td>Energy, water supply, gas</td>
<td>2</td>
<td>4</td>
<td>0</td>
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<tr>
<td>Manufacturing</td>
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<td>2.0</td>
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<td>Construction</td>
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<td>3</td>
<td>0</td>
<td>4.4</td>
<td>3.0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Sector</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
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<tbody>
<tr>
<td>trade, repair motor vehicles</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotels, restaurants, tourism</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0.7</td>
<td>1.3</td>
</tr>
<tr>
<td>Transport, storage and communication</td>
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<td>4</td>
<td>0</td>
<td>8.8</td>
<td>4.9</td>
</tr>
<tr>
<td>Banking, finance insurances</td>
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<td>19</td>
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<td>13.6</td>
<td>8.7</td>
</tr>
<tr>
<td>Real estate, renting</td>
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<td>0</td>
<td>0</td>
<td>10.8</td>
<td>10.6</td>
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<tr>
<td>Other Commercial Services</td>
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<td>1</td>
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<td>n/a</td>
</tr>
<tr>
<td>Public Administration, social security, police defence</td>
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<td>16</td>
<td>5</td>
<td>7.6</td>
<td>11.7</td>
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<tr>
<td>Health and Social work</td>
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<td>1</td>
<td>9.1</td>
<td>23.5</td>
</tr>
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<td>23.7</td>
<td>18.5</td>
</tr>
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<td>Other Community, social and personal services</td>
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<td>3</td>
<td>1</td>
<td>4.3</td>
<td>2.2</td>
</tr>
</tbody>
</table>

**Source:** Ongoing Tracer Study by the National Council of Higher and table 5.5 of the Namibia Labour Force Survey 2008.

**References**

1 Polytechnic of Namibia Strategic Plan-3 (2009 – 2013).
2 Polytechnic of Namibia Strategic Plan 1 (PSP-1), p. 15.
3 Polytechnic of Namibia Strategic Plan 1 (PSP-1), p.2.
Ibid.

Polytechnic of Namibia Strategic Plan (PSP-2), p.4.

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Ibid.

Polytechnic of Namibia Annual Report 2007, p.11.

Polytechnic of Namibia Annual Report 2008, p.35.

Polytechnic of Namibia Annual Report 2010, p.5


Polytechnic of Namibia Annual Report 2006, p.11.


Polytechnic of Namibia, Audit Portfolio, June 2011.

Ibid.

The Audit Portfolio Report was used as one of the sources during this study and therefore there is no need to provide detailed findings emanating from that particular report.

Polytechnic of Namibia: Profile 2010.

Polytechnic of Namibia Annual Report 2009, p.43.


Ibid.


Ibid.

Ibid.


Polytechnic of Namibia: Profile 2010.