INTER-UNIVERSITY COUNCIL FOR EAST AFRICA

# Status of Research and Innovation Capacity Building in East Africa

## The Linkage of Higher Education, Research and Innovation for Human Resource and Entrepreneurship Development through Academic-Public-Private Partnership

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**INCEPTION REPORT**

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INTER-UNIVERSITY COUNCIL FOR EAST AFRICA, KAMPALA

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**INCEPTION REPORT SUBMISSION LETTER**

Prof. Mayunga Nkunya
Executive Secretary
Inter-University Council for East Africa
P.O BOX 7110, Kampala, Uganda

Dear Prof Nkunya:

We, the undersigned, offer to provide the consulting services to conduct a **Baseline Survey on Status of Research and Innovation in East Africa for Developing a Research and Innovation Capacity Building Program** in accordance with your invitation of 4th August 2014 and **Inception Meeting of** 16th August 2014 at EABC Arusha, Tanzania . We are hereby submitting our Inception Report which shows our understanding of the assignment, our proposed technical approach, and the required time frame. In addition this Inception Report also indicates the resource requirements for undertaking the study.

We undertake, to initiate the consulting services related to the assignment not later than the 30-08-2014

Most Sincerely

MOHAMMED KERRE
EXECUTIVE DIRECTOR

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## Abbreviations and Acronyms

| | |
|---|---|
| AT | Appropriate Technology |
| CAGR | Compound Annual Growth Rate |
| CM | Common Market |
| CoE | Centres of Excellence |
| CU | Customs Union |
| EAC | East African Community |
| FDI | Foreign Direct Investment |
| GDP | Gross Domestic Product |
| HRST | Human Resources in Science and Technology |
| IBM | International Business Machines |
| ICT | Information Communication Technology |
| IP | Intellectual Property |
| IPR | Intellectual Property Rights |
| IT | Information Technology |
| ITA | Information Technology Agreement |
| MDA | Ministries Departments and Agencies |
| MNEs | Multi-National Enterprises |
| MU | Monetary Union |
| MUHAS | Muhimbili University of Health and Allied Sciences |
| OECD | Organisation for Economic Cooperation and Development |
| OER | Open Education Resources |
| PhD | Doctor of Philosophy |
| PPPs | Private-Public Partnerships |
| PROs | Public Research Organisations |
| R&D | Research and Development |
| S&T | Science and Technology |
| SME | Small and Medium Enterprises |
| STEM | Science Technology Engineering and Mathematics |
| TFP | Total Factor Production |
| TOR | Terms of Reference |
| TRIPS | Trade -related intellectual property rights |
| USA | United States of America |
| WIPO | World Intellectual Property Office |

# 1. Introduction and Background

## 1.1 The East African Community Treaty and Its Achievements

East African Community (EAC) is a relationship forged initially by three Partner States (Kenya, Tanzania and Uganda) and which has since expanded to comprise five Partner States - Burundi, Kenya, Rwanda, Tanzania and Uganda. On 30th November 1999, the East African Community (EAC) Partner States signed the Treaty for the Establishment of the East African Community. This Treaty came into force on July 7, 2000. The Treaty, in Article 5, provides that the EAC Partner States shall undertake to establish among themselves a Customs Union (CU), a Common Market (CM), a Monetary Union (MU) and ultimately a Political Federation. Achievements realized in this direction, over the last 14 years include the establishment of the CU and the CM, the successful conclusion of the negotiations on the East African Monetary Union[1], and laying the framework for the realization of a Political Federation.

The principle objective of the CU is to deepen the integration process through liberalisation and promotion of intraregional trade, promotion of efficiency in production in response to intraregional competition among businesses, enhancement of domestic cross border and foreign investment and promotion of industrial diversification with a view to enhance economic development. The CM on its part is designed to enhance and institutionalize the guaranteed provisions in the Protocol through harmonization of policies, legal and regulatory framework and establishment of supportive institutions to facilitate private sector investments, efficient and effective service delivery and wide stakeholder involvement. Progress made by the EAC so far in reducing tariff barriers, dismantling non-tariff barriers and liberalizing capital markets has opened up opportunities in trade and international investment. Openness increases the size of markets available to innovators and consumers, while facilitating the spread of knowledge, technologies and new business practices. Another aspect of openness that is equally important is about culture and a readiness for change – recognising that knowledge and ideas are important for economic growth and being willing to transfer and share these among economic agents expands opportunities for economic development.

In order to realize an informed and lasting regional integration process, the Partner States in Article 102 of the Treaty agree to undertake concerted measures to foster cooperation in education and training within the Community by (a) coordinating their human resources development policies and programmes, (b)harmonizing curricula, examination, certification and accreditation of education and training institutions through the joint action of their relevant national bodies charged with managing and promoting higher education, and (c) exchanging information and experience on issues common to their educational systems from which they would collaborate in putting in place education and training programmes. These actions and processes would deepen and cement the process of

[1] Partner States are at different levels of signing and ratifying the EAC Monetary Union Protocol.

integration and development, and particularly promote openness through a common market structure and a common higher education area - the main drivers behind promoting technological innovation and productivity gains as envisaged in the 4th EAC Development Strategy, and individual Partner State development visions.[2]

The EAC through the Inter-University Council for East Africa (IUCEA) is undertaking higher education reforms in order to ensure demand for efficiency and competitiveness, and increased mobility, internationalisation and cross-border recognition of institutions and programmes. Higher education reforms are within the African Union Charter on regional cooperation and training of human resources, the African Union's 2nd Decade of Education for Africa 2006-2015 and the Arusha Convention, which strengthens the IUCEA within its mandate (Act 2009) to spearhead the development of strategies for harmonised and pro-active EAC higher education system, live to the dynamics of development.

### 1.2 Industrialisation Policy and Strategy

The EAC has made a commitment to transform the regional economy through industrialisation. The region's overriding objective is to create a modern, competitive and dynamic industrial sector, fully integrated into the global economy. This commitment is anchored on Articles 79 and 80 of the EAC Treaty, common principles of the EAC Common Market Protocol, and the 2011-2016 EAC Development Plan, which clearly and unambiguously articulate the region's commitment to economic structural transformation through industrialisation. The industrialisation policy lists five main objectives to be realized by 2032:

a) Diversifying the manufacturing base and raising local value added content of resource based exports to 40% from the currently estimated value of 8.62% by 2032;
b) Strengthening national and regional institutional frameworks and capabilities for industrial policy design and implementation; and delivery of support services to ensure sustainable industrialisation in the region;
c) Strengthening Research and Development (R&D), technology and innovation capabilities to facilitate structural transformation of the manufacturing sector and upgrading of production systems;
d) Increasing the contribution of (i) intra-regional manufacturing exports relative to total manufactured imports in to the region from the current 5% to about 25% by 2032 and (ii) increasing the share of manufactured exports relative to total merchandise exports to 60% from an average of 20%;
e) Transforming Micro Small and Medium Enterprises into viable and sustainable business entities capable of contributing up to 50% of manufacturing GDP from 20% base rate.

[2] Each of the five EAC Partner States has a national development vision Burundi Vision 2025, Kenya Vision 2030, Rwanda Vision 20 , Tanzania Vision, and Uganda Vision , all designed to transform the countries into "new" economies.

However, the pillars for such transformation, namely human resource capacity and a vibrant research and innovation system continue to remain formidable challenges. These challenges notwithstanding, the Partner States still have great potential in using the global research and innovation system to effectively harness and support economic development in the region. This is premised on the economic development argument that countries at low income levels may be able to grow faster than those at high income levels, if they used the technology already developed by the latter. This is indeed an argument and its assumptions must be understood - an enabling macro-economic and regulatory environment, firms' capacity to absorb, mechanisms for institutionalisation of the process, and the desire and passion to grow and develop and fully integrated in the global economy.

The challenge to create a modern, competitive and dynamic industrial sector puts the EAC Partner States on the highway for "catching-up".[3] But this "catch-up" depends heavily on two factors:

- social capability (in particular, an appropriate institutional framework, government capability in economic policy- making, and technological and skill levels in the population), and
- technological congruence (the suitability of technology from high income countries for use in the EAC Partner States).

Once 'catch-up' potential is exhausted, Partner States will need to expand their indigenous science and technology base, as they take advantage of new technologies through "leapfrogging"[4], and negotiate the deployment of advanced technologies ahead of their deployment in developed countries. This, for example, is the case in the petrochemical industry, where a large number of the most up to date large scale plants can be found in developing countries in the Middle East and South East Asian countries. As some of the EAC Partner States emerge as potential major oil and gas suppliers, they are bound to attract this attention.[5] The question, though, will be placed on their readiness in terms of macroeconomic stability, political stability, basic infrastructure such as communications, electricity and transportation, and the supply of human resources and capital. These factors are critical for deploying existing or new technologies.

In fourteen years since its establishment, the EAC has made tremendous progress. Having established its own customs union in 2005, followed by a common market in 2010, good progress is being made toward implementing the free movement of labor, capital goods and services. What this means is that instead of five separate countries that offer no real critical mass, you have a market of more than 150 million people, a combined GDP approaching US$100b and an economic growth rate in excess of 6% over the past decade. These key numbers put the EAC in the same category as

[3] IUCEA, Situational Composite Report: EAC Higher Education Qualifications Gaps Study, 2014

[4] See Professor Keto Mshigeni's (Vice Chancellor, Hubert Kairuki Memorial University) discussion at the 2nd Academia-Private and Public Sector Forum and Exhibition, October 21-23,2013 Nairobi Kenya

[5] East Africa has a unique opportunity to avoid repeating other countries' mistakes. Khosla Ventures founding Partner Vinod Khosla argues that the "leapfrogging" mind-set requires policies that foster innovation not imitation.

Bangladesh and Vietnam, both listed among Goldman Sachs' "Next 11," those countries, after the BRIC economies, with the highest potential of becoming the world's largest economies in the 21st century.

### 1.3 The EAC Education, Research and Outreach System

Globally, there is growing consensus among national policymakers and other central socio-economic actors that higher education institutions (HEIs) are important drivers for economic growth and development. They contribute to the creation of a highly skilled and competent labour force, and also produce new knowledge - both essential to the creation of innovation and development of a national economy that is globally competitive. Properly equipped, HEIs can play an important role in creating the innovation and development that will support a national economy in a competitive world. However, how can this process be stimulated?

East African higher education is mainly university-based and state supported. It is responsible for the supply of high calibre human capital. During the 1950s and 1970s, East African higher education institutions built a solid reputation as Centres of Excellence comparable to the best around the world. Makerere University, University of Dar es Salaam, and University of Nairobi, stood out as institutions where teaching and research were at a standard of international repute. Admission requirements and procedures were rigorous and their graduates were recruited into top positions in government and industry in the continent and abroad. High standards were reflected not only in the quality of academic life, but also with regard to the level of remuneration of faculty and staff, the quality of facilities afforded both students and faculty and the prestige they enjoyed in their various countries. Higher education received adequate resources to deliver quality education and to maintain high academic standards. However, with the economic crisis of the 1980s and the implementation of structural adjustment policies which gave priority to basic education, resources to higher education dwindled, resulting in a deterioration of the quality of educational services. Similarly, the withdrawal of donors from higher education led to a further deterioration of the quality of outputs.

Lately, there has been increasing recognition that higher education has the potential to enhance economic development through technological catch-up. In the knowledge economy, higher education can help economies gain ground on more technologically advanced societies. However, the adoption of new technologies demands skilled labour to unlock the potential to increase productivity and economic growth. The expansion and strengthening of higher education in East Africa is expected to promote faster technological catch-up and improve the abilities of the Partner States to maximize their economic output. In particular, the transformative capacity of higher education in agriculture (through modernization of the production chain) is testimony to that effect. Furthermore, the strengthening of higher education will impact positively on basic education through the production of better trained teachers, especially for science, mathematics and technical subjects.

East African higher education is now at a crossroads. At national levels, the democratization and liberalization processes have put higher education institutions in a more vibrant and more transparent environment. At the global level, the impact of the unfolding knowledge society is reshaping higher education. The institutions will remain competitive only to the extent that they embrace the knowledge economy and networks, and to turn out an increasingly diversified range of skills in response to development needs. The key challenge for the higher education systems resides in training and preparing East Africans for the emerging new economy and in maintaining access and quality of outputs.

In the area of science and technology, disparities between East Africa, Africa and developed countries in capacity are acute, and differences in economic growth due to the distribution, use, adoption, adaptation and generation of knowledge are widening. East Africa is lagging behind as a complex set of institutions, agents, policies, linkages and networks are required to harness the benefits of science and technology (S&T) for development. In addition, the gender gap in higher education has remained stagnant, particularly in science related disciplines, where female enrollment rates are only a third of the total. The role of governments in enabling science and technology-led growth has gone beyond that of facilitator of technology development. Governments are increasingly taking cognizance of the fact that the actors are more diverse and with a growing incidence of university-industry collaboration and public-private partnerships.

A HEI's academic capacity consists of a range of factors, among them being:

- its number and proportion of academics with doctorates and research expertise,
- its ability to attract good undergraduate and postgraduate students,
- its ability to engage business, communities and government in research and innovation as well as in consultancies, and
- to be a part of international academic/funding networks.

A strong academic capacity enables a higher education institution to establish extensive links with the larger society, which potentially lead to an increase in and diversification of financial resources. In higher education, basic resources are not only financial, but are also human and reputational, with students, finance and high-potential academic staff following in response to reputation, research programmes and more funding.

This project seeks to strengthen the capacity of higher education institutions, and research organisations (private and public alike) in research and innovation in a sustainable and fulfilling manner.

# 2. The Dynamics of the Proposed Project

## 2.1 Content Review

This study is designed to identify a number of major findings in literature and practice. We can therefore premise it on four key statements of fact:

- First, the extent to which a country's workforce actively engages in research and innovation is strongly determined by (a) the education philosophy of the country, and (b) particular work organisation practices,
- Second, achieving high academic standards within a country for the largest proportion of school students not only supports high participation in post school education and training but creates a workforce with greater potential to engage productively with research and innovation,
- Third, the predominant form of innovation at firm level is incremental, and this points to the central role of the broader workforce in the generation, adaptation and diffusion of technical and organisational change, and
- Finally, there are large differences across the Partner States in workforce skill formation systems, especially for vocational skills. Such differences result in large disparities across nations in the share of their workforce with formal vocational, technical and academic qualifications, and in the level of these qualifications. The resulting differences in the quantity and quality of workforce skills are a major factor in determining the observed patterns of innovation and key aspects of economic performance.

These four statements will guide the design questions and field assessment actions. They will also inform the analysis processes adopted for this study in review of materials on research and innovation as shown in following sections ((i) to (viii)).

### (i) Research and Innovation

R & I is the process of translating knowledge into action. For the EAC Partner States to realize required levels of research and innovation a number of targeted reviews of innovation policy and regulatory framework and broader economic surveys are required. The current status highlights that, while there are a number of critical policy areas that are common to all countries, such as improving framework conditions, intellectual property rights, academia-industry linkages and competition, the details differ according to Partner State characteristics and stage of development. Therefore, whereas this study is designed to lead into the development of a capacity building programme, it is obligated to come up with some specific policy recommendations for the EAC Partner States to ensure evolution and growth of a strong and outcomes-based research and innovation system, which among

other things could encourage the business sector to engage in productivity-enhancing innovation activities.

Research and innovation financing in the region is shouldered by the governments to the extent that spending by the business sector is relatively negligible compared to developed countries' average. A review of the 2013/14 financial budgets of all the five Partner States of the EAC reveals that the prime targets were to sustain a high economic growth. Therefore, they increased their budgets for scientific, industrial, agricultural and technological innovations, as well as priority infrastructure to meet this target. This is in line with the fourth EAC Development Strategy (2011-2016) that outlines a particular focus on the development of innovations and priority infrastructure as some of the key factors in the development and competitiveness of the regional economies.[6] Additionally, this development strategy takes into account the national visions and strategic development plans of the EAC Partner States and brings them into harmony - heading "together towards regional convergence into a middle income economy by the year 2020."[7]

The bulk of research and development is carried out by the Partner State governments, with most scientists working in public universities and research institutions, patenting is low and process, rather than product, innovations account for the bulk of innovative activity in the business sector.

The principal debates in East Africa now focus on competences and absorption capacity for research and innovation. Competence in research and innovation focuses on the idea of generic 'skills for innovation'; the contribution of skills supply in promoting innovation; the apparent paradox of simultaneous skill shortages and 'over-qualification' in the workforce; the notion of 'high or low-skill equilibrium'; how industry and training systems balance the demands for workers to acquire firm-specific skills of immediate value in the market against more general skills and knowledge that may be relevant to a broader range of firms and technologies over a working life; the role of different work organisation systems in promoting and utilising workforce skills and whether technical change is fundamentally biased towards demanding higher level workforce skills. Absorption capacity, on the other hand focuses on the input-output process of education and research, the evolution and growth of enterprise, the desire of enterprises to involve in research and innovation, and the capacity of these enterprises to receive and apply research knowledge, and the level of incubation and commercialisation of innovations.

**(ii) Innovation and Growth**

The TOR also look at innovation as the key to growth and development. Indeed innovation has been described as the creative use of various forms of knowledge when responding to market-articulated

[6] Deepening and Accelerating Integration, EAC Development Strategy 2011-2016, August 2011, http://www.eac.int.

[7] Mwapachu, J.V., EAC Experience, Achievements, Challenges and Prospects. The dynamics of Deepening Regional Integration, Paper Presented at the 2nd EAC Symposium, Arusha 28 April 2011, http://www.eac.int.

demands and other social needs (OECD 1999a). For measurement purposes, it is defined by the Oslo Manual as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD & European Communities 2005, p. 46). The actual and perceived importance of each facet of innovation will differ across countries, in accordance with factors such as resource endowments, industrial structure, and culture. For some countries, technological innovation and research and development (R&D) are seen as central, while for others, non-technological innovation and adoption of technological advances from other sources are more prevalent.

The Partner States of the EAC, are strengthening cooperation with China, South Korea and Japan to support industrial, agricultural and technological innovation. Similarly, some Partner States (Uganda, Rwanda and Kenya) have established presidential initiatives to support innovation and science. They have also started attracting international innovation companies (such as IBM and Phillips) who have already opened their East Africa innovation hubs in Nairobi. This presents an EAC that is seen as taking the road to affluence and growth. However, the missing middle in this is the role of local research and innovation, the place of small and medium enterprises, and the process for sustainability and institutionalisation of the research and innovation efforts of the Partner State governments, and the international innovation companies. Finally, the region is yet to (i) define and develop EAC innovation index and measurement system, and (ii) put value to research and innovation efforts, especially because the relationship between technological progress, innovation and economic growth changed in the 1990s, with innovation and technological change becoming increasingly important for economic performance as was indicated by rising investment in innovation[8], a surge in patenting driven by rapid innovation across all technology fields, and a widening of innovation activities across sectors.[9] Investment in ICT made an important contribution to growth and labour productivity across the OECD, particularly where this investment was combined with other organisational assets such as new business strategies, business processes and organisational structures, and better worker skills.

The EU, USA and East Asian worlds now put greater reliance on "intellectual assets" as the basis for innovation-oriented activities. While there is no one globally accepted definition of these assets, there is general agreement that they include R&D, patents and trademarks, as well as human resources and capabilities, organisational competencies and "relational capital". These assets are strategic factors for value creation by firms and initial analyses for Finland, Japan, the Netherlands, the UK and the US suggest that total annual investment in intellectual assets amounts to between 7.5-11.7% of GDP – a level similar to investment in physical assets. These estimates suggest that the

[8] Investment in research and innovation in the developed world and East Asia became more market oriented, with more business research and development activities.

[9] At this time the services sectors experienced increasing investment in research and development

factors associated with the growth of the knowledge economy are even more wider and more important than previously thought. This approach to innovation management is still alien to East Africa. Thus, methodological challenges mean that national accounting systems and traditional corporate reporting standards still do not reflect the role of these assets as a productive force, relying instead on methods that favour financial or physical capital. This leads to misallocation of resources, due to a failure to reflect the true contribution of intellectual assets to value creation.

**(iii) Industrial Clusters**

At the broadest level, clusters are networks of interdependent firms, knowledge-producing institutions, bridging institutions such as providers of technical or consultancy services, and customers, linked in a production chain which creates added value. At the EAC level, we could regard them as a reduced-form national innovation systems, where system elements help stimulate the emergence of specific kinds of innovation in various segments of a national economy. Do they exist in this definition and form? Are they structured in such way as to inform the development process both at the lowest and highest levels of enterprise and thinking?

The concept of a cluster is fluid – there is no one definition setting out the level of linkages between actors, the degree of resource sharing or the "completeness" of the value chain. Every country or region has its own selection of clusters and specializations with different characteristics and roles in the economy. With value chains increasingly internationalized, clusters typically transcend geographic boundaries. Technology-based clusters are particularly likely to be part of wider international clusters, while more mature clusters may function primarily at a national or regional level. Evidence suggests that the most significant elements of the value chain responsible for innovation are the firms that trade with each other along the chain as suppliers or customers. Inter-linkages are not necessarily focused on technologies – organisational and marketing knowledge are also shared.

Co-operation in clusters is increasingly required for firms to be successful – it offers a direct way to improve economic performance and reduce costs, and linkages with demanding consumers can play an important role in guiding innovation and technological change. But the emergence of clusters takes time, and their birth may be related to particular historical events or to the availability of natural resources; their development trajectories are highly individualised. Thus the role of government is mainly as a catalyst and broker in strengthening cluster formation.

This study will be looking at what is currently defined and practiced as clusters in terms of these observations, and drawing the linkages to structural and functional relationships with key actors.

### (iv) Technological Fields and Industrial Sectors

Policy needs vary across technological fields and industry sectors. The challenge is to understand the distinctive properties of particular areas so that a consistent and transparent policy mix can be designed, one which combines generic innovation policies with customized policies adapted to the characteristics of the sector. This calls for specialised sector studies.

The service sector is one important area with high employment opportunities and potential for growth. In general, government policies have traditionally focused on facilitating R&D and technology diffusion in sectors such as manufacturing and in larger firms, with industrial research and development institutes existing in nearly all the Partner States. Given the significant differences between the process of innovation in services and other sectors, governments need to remain aware of these differences and of the characteristics of services when designing and implementing policy instruments. Some instruments of government policy may need adjusting, to remove implicit policy biases against services.

### (v) Science, Technology, Engineering, and Mathematics (STEM)

STEM exemplifies access to opportunity and advancement. This study will outline the state of STEM education in East Africa, and suggest steps locally and across Partner States in order to benchmark and increase future participation in STEM studies and careers. It is widely acknowledged that East Africa is suffering from low achievement and low interest among students in STEM subjects and STEM-related careers compared to others across the world.

Indeed, despite some countries showing a small positive increase in recent years, the region's future competitiveness in innovation is in peril, as the combined benchmark of achievement, interest and demographic change relating to STEM continues to show a downward trend in the next few years, unless major systemic changes are introduced in both formal and informal STEM education to mitigate this decline. This study will address this issue by outlining key priorities and successful models for scaling up STEM enrichment and enhancement activities within the informal field, as well as formal STEM education through schools and higher education institutions.

We are aware that tertiary education plays a vital role in improving local skills and expanding the indigenous science base. However, some Partner States lack the domestic capacity to meet demand for tertiary study, while others could benefit from foreign experience and knowledge to improve the quality of the tertiary education system. Cross border education, encompassing student mobility, and mobility of programmes and providers/institutions, can help to quickly expand a tertiary education system and increase a country's stock of human capital and should be considered as part of capacity development activities in the EAC Partner States. While student mobility is already relatively

established and has shown to increase capacity, there is scope for structured mobility of programmes and institutions, supported by appropriate quality assurance procedures. To facilitate this process the Inter-University Council for East Africa (IUCEA) has rolled out a structured programme to establish a Common Higher Education Area by 2015.

Country circumstances, however, will determine the ability of individuals and the state to generate private and social benefits from higher education. This is a challenge to all the five Partner States, where failure to create opportunities have resulted in outflows of skilled individuals, aggravated by selective immigration and research funding policies in receiving countries that attract the top talent. While gains accrue to some Partner States from the knowledge flows from their diaspora abroad, some returns are better captured with return flows of migrants. Return flows can increase if economic opportunities for the highly skilled individuals expand in the Partner States, leading to either permanent return, or temporary return, which has been commonly referred to in academic circles as "brain circulation". However, this is not easy and takes time. The economic development of China and India, for instance, has created opportunities for return migration. But this success has been the result of globalisation and the expansion of trade as well as of key investments in education and infrastructure. Contemporary India's specialisation in IT education and production dates from the development of the Indian Institutes of Technology (IITs) in the 1950s. Similarly, Brazil's development of world competitive aeronautics industry dates back from the establishment of an aeronautics institute in the 1940s. This study will, in addition to taking stock of existing population of STEM, look at the special conditions each of the Partner States may be required to or has already put in place to attract back talent and increase, expand and broaden its STEM capacity.

### (vi) The Situation of Master's and PhD Programmes

HEIs in East Africa are established to provide facilities for higher (university) education, including technological and professional education, and for research either directly or through the medium of affiliated colleges, schools or department; to assist in the preservation, transmission and increase of knowledge and in the stimulation of the intellectual life and cultural development of the students. Postgraduate students constitute the pool from which the next generation of academics and top level human capital will be drawn. Unfortunately, the number of master's and doctoral enrolments remains relatively small, with declining trends in some Partner States. Available data show that men dominate postgraduate enrolments, even though institutions are closer to gender parity. Any hope of increasing the low proportion of women in the academy has to start with efforts at improving their numbers in postgraduate programmes. The data also points to low graduation and time-to-completion rates, as well as high dropout rates in some academic programmes. These trends do not augur well for developing an adequate pool of high-quality future academics. It therefore behooves governments, national tertiary educational bodies, universities and the private sector to work

together to develop creative and complementary funding models that promote high quality postgraduate training.

Externally the traditional recipient of university graduates being ministries and research institutions in the region are also increasingly demanding higher education of their newly recruited staff. The establishment of many new private universities in the region is requiring PhD graduates to fill their ranks of lecturers and professors. Moreover, with positive economic growth in recent years, the private sector has grown and it also demands well-qualified PhD graduates to address its international competitiveness.

These increases in demand for PhD graduates do not only relate to the number of graduates but increasingly also to the quality of the graduates and to the relevance of their research work and professional profile to the wider society. This is giving the existing establishment of HEI in the region a lot of challenges and has created an unprecedented pressure for effective and efficient management of the universities PhD programmes. At present the only ones to supply all these stakeholders with PhD graduates are the old established universities, although new and competitive ones have emerged

The HEIs in the region are in the race to create efficient and effective Master's and PhD training systems through strengthening local research capacity and regional networking. Master's degree programmes in East Africa usually take 1 or 2 years. The first year mainly consists of lectures, with the second year spent doing research. In principle, master's programmes conclude with a final paper. In most cases, admission to a master's programme requires a minimum of an upper second class bachelor's degree. Applicants with a bachelor's qualification below upper second class may be required to do a postgraduate diploma in the related field before being admitted into the master's programme. Most master's programmes confer a Master of Science or Master of Arts degree. But there are also degrees which include the name of the discipline, such as the Master of Environmental Studies, the Master of Business Administration, etc. In principle, master's degrees in the five Partner States enable students to pursue a doctorate.

A master's degree is mandatory in order to pursue a Doctorate degree. For many PhD students there are years of non-academic employment between Master's and PhD studies. From being mainly passive recipients of information in their school and most of their university years they have to become proactive problem solvers and knowledge creators, which is no small transformation. The current PhD programmes in the region do not cater for students deficiencies for instance by offering compulsory courses. Therefore supervisors have spend a lot of effort and valuable supervising time teaching students the basics of proposal writing, budgeting and the like[10]. The predominant format for PhD studies is still long narrative books rather than scientific articles which seriously limit the

[10] Some PhD students get delayed because they are unable to write a research proposal for their PhD project.

dissemination of the research and does not train the PhD graduates in effective scientific writing.[11] In order to promote efficiency and effective PhD studies there is a huge need for students to get access to course activities.

This study will examine the architecture for Masters and PhD studies, and attempt to compile data on available capacity and how this is influencing the direction of STEM, R&I and knowledge development and transfer in the region.

### (vii) Technology Competitiveness of Small and Medium Enterprises

Much of the existing technology available to SMEs in East Africa is not sufficient to produce goods of a quality or type that enables them to break into new, expanding or more demanding markets. This is because choosing a technology requires specific skills and knowledge that most SMEs do not have. Making the right technology choice requires capacity to continuously adapt technology to particular needs and continuously improve technology use through innovation. Thus, SMEs need to upgrade their own internal technology effort, which requires innovation. However, innovation cannot be cultivated in isolation but needs a wealth of supporting services, infrastructure, institutions and enabling conditions. EAC Partner States' national innovation systems are weak; science and technology policy does not command as much attention as it should, and institutions of technology are not only under-funded, but are also ill-equipped. SMEs, therefore, operate at lower levels of productivity, competitiveness, profitability and value addition.

There are three episodes that characterize the evolution of SME research and innovation environment in East Africa: industrial research and appropriate technology in the early 1980s, market-based incentives in the late 1980s), and technological capability 1990s onwards. In the early 1980s, the focus was on strengthening industrial research within the MSE sector. Financial incentives and legislation were applied to forestall the problem of weak industrial research. Thus, institutions responsible for industrial research and development were established to enhance technology development and transfer, standardization, and innovations in industry.

Although the appropriate technology (AT) approach to technology development achieved some success, it has been criticized for having minimal impact on the technological capacity of SMEs in the region. It focused on SMEs but failed to narrow the gap between SMEs and larger enterprises. Critics have argued that the AT approach is responsible for the failure of the Partner States to develop a technology vision since it was understood not in terms of the capacity to produce market or demand-led products but in terms of older generation or manual technologies. The approach focused on increase of technological development of the country; technological development of SMEs should also have been part and parcel of the overall national technology development plan.

[11] Promoting Excellence in PhD Research Programmes in East Africa (Prepare-PhD), Grant Application

From the late 1980s, the policy focus shifted towards market-based interventions within the MSE sector. In line with market-based structural adjustment reforms, the government's role became more facilitative. It created infrastructure facilities and an economic environment for business. Policy thrust targeted new innovative production techniques that would replace imported manufactures, disseminate new technologies, use tender procedures to give preference to MSE bids, and use new building and architectural codes that favour use of SMEs products.

In the 1990s, policies aimed at enhancing technology capability within SMEs were not strikingly different from those of the 1980s. The governments, especially in Kenya, encouraged research and development, linkages between small and large enterprises, through sub-contracting, and strong support institutions involved in technology development and diffusion. Another important policy effort was to improve the product and quality of SMEs and exporters through information exchange, informal technology support and identification of technological and workforce requirements.

Currently, there are minimal "innovations" in the policy framework, as most of the elements of policy have remained generic. Focus remains on enhancement of linkages between small and large enterprises through measures such as business incubation. There is, therefore, need for new direction focusing on enhancing the ability of SMEs to adapt and adopt new technology, enhancing the capacity of institutions that support technology development, improving access to information on available technology, and enhancing provision of technological skills. It is important to note that issues such as commercialization of technology, subcontracting arrangements, programmes for "technopreneurs", and technology benchmarking have been downplayed.

### (viii) Centres of Excellence (Hubs)

East Africa is dotted with Centres of Excellence (CoEs)of all forms and magnitude. They cut across all sectors and behaviours.

IUCEA is keen on developing CoEs as part of capacity building for research and innovation in strengthening SMEs in their contribution to industrial development and growth in East Africa. Therefore in this study we shall define and treat CoEs as organisational environments that strive for and succeed in developing high standards of conduct in a field of research, innovation or learning. Within this definition we propose to categorise CoE schemes according to their strategic orientation, and this yields three CoE types:

a) basic and strategic research
b) innovation and advanced technological development; and
c) social and economic development

Regardless of strategic orientation, all CoEs have in common the notion of excellence, and the particular requirements that come with that label. Some of these dimensions are high research quality and productivity, resource attraction and concentration, international visibility and attractiveness, including staff recruitment, and organisational robustness - good governance.[12] [13] These are higher-order criteria, which are expected to further the strategic goals, be they in innovation or other social impacts.

CoEs are often highly attractive to research and development (R&D) investments and talent in their field. Therefore they possess the ability to absorb and generate new knowledge. Ideally they would distribute and utilize this new knowledge in the form of new capacity in their field, be it research results, innovations or talent. CoEs are typically geographically concentrated and focused on high potential/growth areas in science and industry, but they may also be virtual/distributed and consist of a network of co-operative partners with a coordinating centre.[14] In terms of size, according to the operational definitions employed by some promoters, CoEs can be anywhere from the local R&D group up to regional-level semi-cohesive triple-helix networks consisting of hundreds of researchers.[15]

Most CoE schemes converge on a number of academic and socio-economic goals, a common division being that between schemes that are largely intended to generate scientific excellence, those whose purpose it is to stimulate technological innovation in some sector, and those with more general social objectives including policy support or regional development. In the EAC region the national institutes of policy research and analysis (KIPPRA in Kenya and IPRA in Rwanda) could be classified as such. In addition some CoEs are geared towards educational or learning goals. These are normally dealt with separately, but are increasingly part of the CoE framework, and should in any event be considered relevant to this study.

### 2.2 Project Description

This study is designed to generate data for development of a research and innovation capacity building programme to support research and innovation development in the five Partner States of the EAC.

#### (i) Project Scope

[12] Orr, D., M. Jeager and J. Wespel.(2011), New Forms for Public Research: A Concept Paper on Research Excellence Initiatives, OECD, Paris.
[13] Aksnes, D. et al (2012), Centres of Excellence in the Nordic Countries: A Comparative Study of Research Excellence Policy and Excellence Centre Schemes in Denmark, Finland, Norway and Sweden, NIFU, (Nordic Institute for Studies in Innovation, Research and Education), Oslo.
[14] Professor Mayunga Nkunya, at a recent briefing mission on the IUCEA Research and Innovation Program, Arusha 16 August 2014
[15] Hellstrom, T.(2011), "Homing in on Excellence: Dimensions of Appraisal in Centre of Excellence Program Evaluation", Evaluation, Vol. 17, No.2. pp.117-131

This study covers the five EAC Partner States (Burundi, Kenya, Rwanda, Tanzania and Uganda) and will be conducted within the EAC Integration Agenda as defined by the EAC Treaty. The scope and detail of the study is extensive and highly demanding involving research and innovation; science technology engineering and mathematics, and development of centres of excellence - otherwise known as innovation hubs.. This study has two primary variable STEM and CoE critical in developing R&I capacity. These (STEM and CoE) may be instruments for capacity building in so far as they realize capacity potential for human resource development, enhance organisational capacity and create institutional and legal frameworks in the research and higher education field, as well as their effects on innovation and socio-economic development

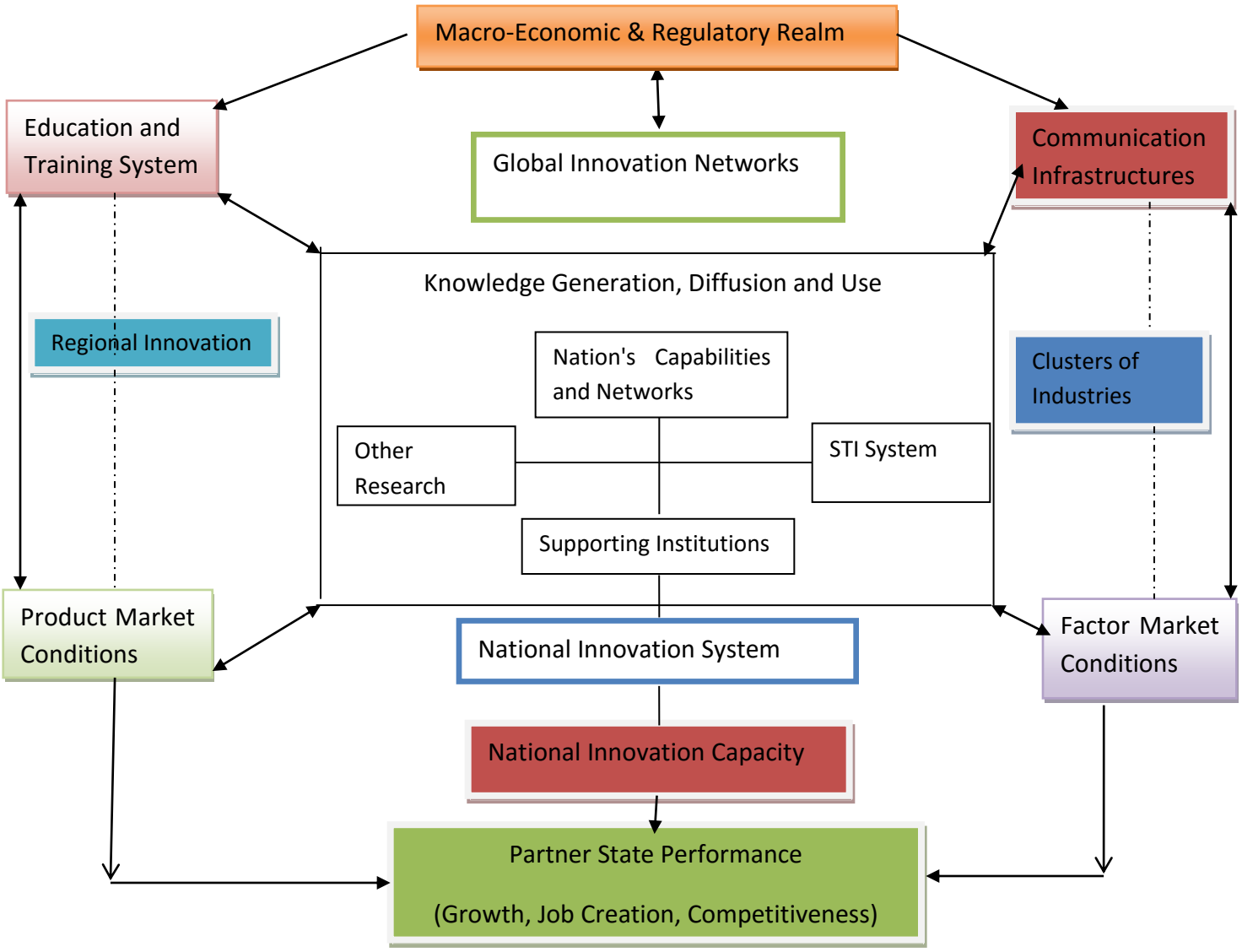
The study, conducted under the spirit of the EAC integration agenda as defined by the Treaty Establishing EAC, approaches research and innovation within the framework of the Treaty, the 4th EAC Development Strategy, IUCEA Strategic Plan 2011-2016, EAC Industrialisation Policy and Strategy, and national long-term development visions of the Partner States.

The architecture within which the study will be undertaken is schematically represented in Figure 1, which also identifies the actors and linkages defining the EAC research and innovation system, and benefits from the definition of innovation system as identified by the Organisation for Economic Cooperation and Development (OECD) as having three pillars- the education system, the research system, and the business system, and will be done within this framework. Application of this matrix in the audit of the EAC research and innovation system should help to explain why we are where we are in terms of relative focus to/of public and private sectors in funding and performing research and development, different objectives and instruments of government support, different roles of government ministries, and different scientific, technological and industrial specializations all contributing to different institutional arrangements and outcomes towards national research and innovation capacity.

### (ii) Project Purpose and Direction

Therefore, the study will interrogate six study factors at global, regional, national, institutional and firm levels with the aim of establishing empirical information regarding the status of STEM, research and innovation and the evolution and activity of designated hubs in the region. The study factors include: policy regime, legal and regulatory environment, national and institutional incentives, political will and commitment, capacity types and levels, and institutional arrangement. In addition, the input-output process for STEM development from early childhood development education to postgraduate and postdoctoral engagement will be reviewed with the aim of establishing gaps in relation to a desired status on one hand, and the quality of the STEM programmes and mitigation measures on the other.

Figure 1: The EAC Research and Innovation Study Architecture




Source: Adopted from OECD 1999a and aligned for the EAC

### (iii) Project Aims and Objectives

The aim of this study is to provide practical information to decision makers in research and innovation system and to build the institutional capacity of higher education to interface more productively with the business sector in research and innovation. Specifically the study will be guided by the following specific objectives:

a) To establish the policy and regulatory environment for research and innovation at the institutional, national and regional levels;

b) To understand and evaluate the benefits of the growing importance of research and innovation collaboration between academia, public and the private sector;
c) To investigate the status and capacity requirements for research and innovation in terms of human resources, physical infrastructure, and funding and governance context;
d) To develop a research and innovation management and coordination framework aimed at enhancing the contribution of research and innovation for building knowledge-based economies, socio-economic transformation and improved living standards of the people of East Africa.

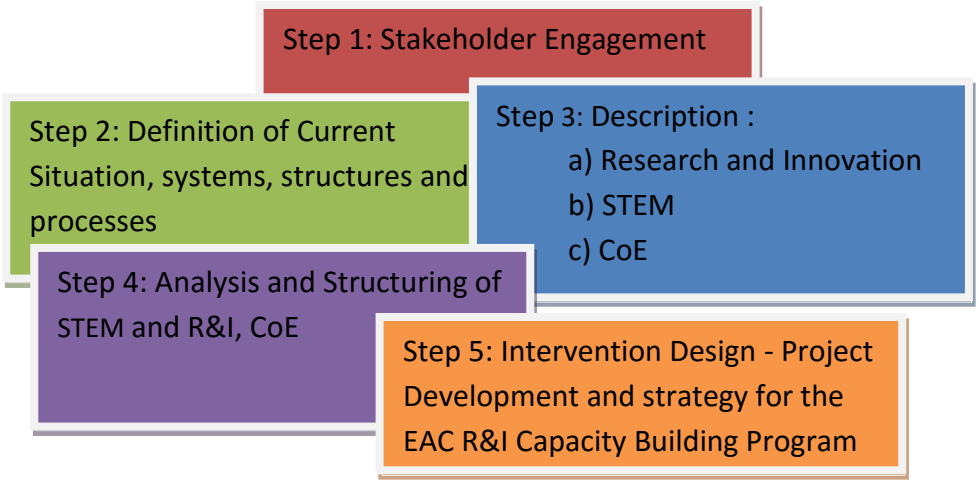
Addressing these objectives adequately should yield empirical evidence regarding R&D and innovation in East Africa, which will be necessary for generating policy-relevant indicators to monitor progress of specific interventions and to support evaluation based on the evidence provided by such indicators. A reliable set of indicators generated in such a sustainable and predictable manner should help alleviate the levels of uncertainty in the innovation ecosystem in East Africa.

### (iv) The study Structure and Process

A review of the Terms of Reference and materials supplied to us on R&I, STEM and CoE brings out one major task to be carried out to realize the purpose, aims and objectives of the study. This is to establish the current status of three key drivers of development (a) research and innovation (R&I), (b) Science, Technology, Engineering and Mathematics (STEM), and (c) Hubs, and their contribution to economic growth and development in East Africa. To undertake this the following activities, we believe it will be necessary to:

- Review existing policies affecting research and innovation and their applications in the region
- Review the resources (physical, human, and financial) availability and capacity relating to research and innovation in the region
- Review the institutional capacity and arrangement for research and innovation
- Review the relevance of the current research and innovation education needs to regional needs
- Propose how to nurture values which promote the learning of STI in schools and institutions of learning
- Develop a conceptual framework for a regional innovation system for East Africa
- Propose a framework for research and innovation management and coordination in the EAC region, stressing the need for a collaborative approach between the academia, public and private sectors

The process towards this structure includes




## 2.3 Survey Issues

Analysis of Chapter 1 and sections 2.1-2.2 of Chapter 2 brings out a number of survey issues to be addressed through review of documents, interviews with key informants, structured survey questionnaires and in consultative meetings with stakeholders. These issues and expected actions are summarised in Matrix 1 Data Survey Matrix

Matrix 1: Data Survey Format

| Survey Subject | Information Required | Information Source | Method of Collecting Information |
|---|---|---|---|
| Policy Regime | • Position of R&I in regional, national and institutional, and firm level planning and development<br>• Regional, national, institutional and firm level policy guidelines on research and innovation<br>• Policy guidelines on education and training programs for STI development<br>• Core policy principles driving STEM education, STEM | • EAC Treaty<br>• EAC 1st-4th Development Plans<br>• National Development Vision<br>• National R&I Policy<br>• National Development Plan<br>• National MTEF<br>• National Research Science and Technology Policy<br>• National industrialisation Policy<br>• Firm Level policies and guidelines | • Web Search<br>• Interviews with stakeholders<br>• Access to hard copies from government departments & libraries |

| | | | |
|---|---|---|---|
| | workforce and STEM networks | • Institutional Level R&I, STI, Policies | |
| Legal and Regulatory Environment | • Practice, Discipline, mechanisms of regulation, enforcement and execution<br>• Certification and affiliation | • Acts of Parliament<br>• Operational Manuals<br>• Rules and Regulations<br>• Presidential Decrees | • Web Search<br>• Interviews with stakeholders<br>• Access hard copies from government departments |
| National and Institutional Incentives | • investment practices<br>• government schemes designed to promote research and innovation<br>• government schemes to encourage private sector investment in R&I | • National Budgets<br>• Institutional Budgets<br>• Fiscal Policy<br>• National Financial incentives and Management Policy<br>• Institutional financial incentives and management policies | • Web search<br>• Review of documents<br>• Interviews |
| Institutional Capacity | • R&I technical, strategic, communication, administrative capacity<br>• incubation<br>• networks and linkages<br>• Absorption capacity<br>• sustainable processes | • Human Resource Plan<br>• incubation Policy<br>• Technology adaptation policy<br>• Records of Personnel<br>• Research projects<br>• Intellectual Property rights and resulting patents, copyrights | • Web search<br>• Interviews<br>• Documents |
| Resources | • availability of space, equipment, funding, human capital, etc<br>• innovative financing programmes | • Budgets, Human resource plans, audited accounts<br>• Banking and Investment Policy | • Web search<br>• Interviews<br>• Documents |
| Status of STEM in R&I human resource development | • Policies to promote STEM<br>• Practice in education system<br>• adequate human resource flow<br>• STEM enrolment and retention ratio<br>• Key priorities<br>• Successful models | • School and HE education and training programs<br>• Register of STEM professionals at different levels (private and public sectors) | • Web search<br>• Interviews<br>• Documents |

| | | | |
|---|---|---|---|
| EAC Innovation System | • Regional/national policy regime<br>• regional/national incentive structure<br>• regional/national measurement system<br>• innovation indexing and certification | • EAC Secretariat<br>• EAC Innovation framework<br>• Indexing and certification body | • Web search<br>• Interviews<br>• Documents |
| Research and Innovation Management Framework | • Leadership in research and innovation by government<br>• Leadership of research in institutions<br>• Management to support leadership of research in institutions<br>• Leadership of research institutions<br>• Management to support leadership of researchers<br>• Personal behaviours and qualities of research leaders and managers | • Policies on Research and innovation<br>• governance structures and systems<br>• Systems for hiring and deploying personnel in research and innovation<br>• Research student management systems and structures<br>• Performance management documents<br>• Global research works | • Web search<br>• Interviews<br>• Documents |
| Academic-Public-Private Partnership | • working relationships<br>• commitment and action | • Partnership Contracts<br>• Existing Partnership practices | • Web search<br>• Interviews<br>• Documents |
| Relevance of R&I | • research needs versus community or industry needs<br>• impact of research | • Research Portfolio | • Web search<br>• Interviews<br>• Documents |
| Hubs | • characteristics<br>• organisation and management<br>• structures and systems<br>• priorities<br>• sectoral distribution | NCST<br>NACTE<br>Directorate of industrial training<br>NCHE<br>National industrial research and development agencies | • Visits and observations<br>• documents<br>• interviews |

## 2.4 Deliverables

This study is designed to yield the following:

a) A draft Study Report in Soft Copy for Stakeholder Validation
b) Final Study Report in Soft Copy
c) Project Document Framework for R&I Capacity Building

## 2.5 Study Duration

The study is designed to take 30 calendar days, a very short duration by any standards. However, the proposed approach and study management arrangements should enable the completion of the assignment in the budgeted time.

## 2.6 Comments on Services and Facilities Provided by IUCEA

IUCEA has committed itself to supply necessary resources to make the study realize its objectives and contacts with Partner States. This commitment includes field logistics - travel arrangements and contacts with partners in the field, and facilitation of any planned meetings and workshops at which this subject will be discussed in line with the study.

# 3. Proposed Plan for Executing the Work

## 3.1 Approach and Methodology

In carrying out this study we propose to employ the process consultancy approach (PCA) – which is both participatory and consultative - under which the consultant works closely with the stakeholders from the known to the unknown. The PCA entails, among other things, extensive consultations and dialogue with the client for the consultant to gain a firm grasp of the background and scope of the assignment. The approach also has two advantages for the stakeholders, and other interest groups in the assignment: (a) allowing maximum involvement of the stakeholders in the execution of the assignment - the client takes ownership of the study assignment implementation process and the outcome(s) of the process, and (b) ensures participation of primary stakeholders in shaping the process and the outcomes of the study.

The Consultant will use different methods of information and data collection including field content review visits, observations, questionnaires, interviews, sampling and mapping. These methods will generate sufficient information to arrive at adequate quantitative and qualitative findings, conclusions and recommendations to meet the objectives of the study.

***Content Review***

We propose to study and review available documents (hard and soft copies including web-search) on various aspects of the three key pillars of this study - R&I, STEM and CoE within East Africa and globally to establish the trends, practices and potential to inform the design of a practical and successful capacity building program. At institutional and firm enterprise levels the consultants will also review organisational and programme documents in order to understand research and innovation priorities and plans in the context of East Africa. In addition, these documents should inform on research and innovation policy framework, private sector and investment policies, the R&I financing, legal and regulatory framework, and institutional arrangement to supporting R&I, STEM and development of CoE.

Content review will be the first step in collecting data on such important factors as Partner State structures, systems, institutional arrangements and processes for STEM development, evolution and growth of CoEs and their impacts, and the practice of research and innovation in national and regional development.

***Consultative Meetings***

Consultative Meetings will be held at government, institutional and firm enterprise levels in Partner States. These meetings will also include briefing and debriefing meetings with the client, and the proposed stakeholder validation workshop, and the Forum and Exhibition Meeting in October.

a) Through such meetings the consultants will be able to gather more information and clarification on issues arising from the key thematic areas - R&I, STEM, CoE
b) The meetings will also provide an opportunity for the client to review and evaluate progress and to suggest appropriate adjustments to the assignment implementation process.
c) When the draft report is ready, it will be presented to the client by the consulting team at a meeting convened for this purpose to enable IUCEA interrogate the process and findings further. The meeting will be a good opportunity for the client to critique the draft and give suggestions on how it can be further refined to meet the aspirations of the study and the future direction of the program.
d) This is an important tool for gathering current "live" data for HEI, research institutions, ministries, government departments and agencies and business firms on the education system and process, financing of research and innovation, incentive regimes, data on postgraduate and postdoctoral programmes and processes and support infrastructure for STEM, CoE and R&I.

Consultative meetings provide an opportunity for direct contact between the Consultant and the source of data (respondent). To this extent it facilitates in-depth probing and cross-checking of facts and figures provided by the respondent(s), thereby making it possible for the Consultant to attain a high degree of data quality assurance.

***Benchmarking***

For the purpose of this study benchmarking is designed to determine, through comparisons with performance or best practice elsewhere. The aim is to determine whether, by comparison with good practice elsewhere, there is scope for doing things better by broadening, widening and strengthening the base for education, research, STEM and innovation. This should help to identify opportunities to improve efficiency and effectiveness, and also identify issues for capacity building in the proposed program. High-level comparisons shall be made with what is going on in the OECD and East Asia countries.

***Sampling***

This study has targeted five different groups of institutions in the research and innovation system:

(a) Knowledge-based institutions:
(b) Research institutions national and international by Partner State
(c) National councils or commissions for higher education.
(d) National councils or commissions for science and technology.
(e) Other public and private sector institutions linked to manufacturing, research, technology and innovation for which two days will be devoted per Partner State.

These groups are viewed as a representative sample of the actors and linkages in the research and innovation system, represented schematically in Figure 1(2.1 page 15). Based on this, there is a

predetermined sample summarise in the Matrix 2 below. According to this matrix the primary data for this study will be collected in a field survey in the five Partner States (Burundi, Kenya, Rwanda, Tanzania and Uganda) in-depth interviews and consultative meetings with representatives of the institutions

Matrix 2: Sample Institutions and Key Stakeholders by Partner State

| Sector | Partner State Representatives | | | | |
|---|---|---|---|---|---|
| | Burundi | Kenya | Rwanda | Tanzania | Uganda |
| Knowledge Institutions | • University of Burundi. | • University of Nairobi<br>• Moi University,<br>• Jomo Kenyatta University of Agriculture and Technology,<br>• Strathmore University,<br>• Mt Kenya University, and<br>• Technical University of Kenya. | • University of Rwanda (College of Science and Technology and College of Business and Economics),<br>• Adventist University of Central Africa,<br>• Kigali Independent University, and<br>• Rwanda Tourism University College. | • University of Dar es Salaam,<br>• Muhimbili University of Health and Allied Sciences,<br>• Sokoine University of Agriculture,<br>• State University of Zanzibar,<br>• Nelson Mandela African Institute of Science & Technology,<br>• Institute of Finance and Management,<br>• Dar es Salaam Institute of Technology. | • Makerere University,<br>• Mbarara University of Science and Technology,<br>• Ndejje University |
| Research Institutions | Institute of Health | KIRDI, KEMRI, KIPPRA, KARI, ICIPE, ILRI | IPRA, ISAR | NIMR, TIRDO, IITA, ARDI, CEAMC | NARO, UIRI, UMRI, UVRI |
| Higher Education Regulatory | NCHE | CUE | RHEC | TCU & NACTE | NCHE |
| Science and Technology | NCST | NCST | NCST | COSTEC | NCST |
| Other Institutions | ECONET Wireless, MEX, | KEPSA, GMC, BAT | RPSF, Bank of Kigali, RwandAir, | TPSF, CRDB, Mohammed | PSFU, Crown Beverages, |

| | | | | | |
|---|---|---|---|---|---|
| | CCI | | SULFO | Enterprise, TANELEC, TANFOAM | Tullow Oil, Mukwano Industries, EA Roofings Ltd, |

### 3.2 Investigation and Analysis Tools

These will include

(i) ***Country Policy and Institutional Assessment Matrix (CPIAM) (Annex 1)*** programmed to gather and analyze

a) The impact of national policies on design and implementation of research and innovation promoting programs
b) national STEM policies
c) progression in STEM
d) The impact of national policies and practices on the competitiveness of the national higher education system;
e) The impact of funding/investment policy for research and innovation;
f) The effects of research policy and innovation on steering the processes of HE reform in desirable directions
g) impact of national policies and incentives regimes on private sector participation in growing research and innovation

(ii) ***Research and Innovation Management Tool*** ( annex 2) to collect and assess data on six important themes in research and innovation management:

(iii) **Centers of Excellence Templates** (Annex 3) designed to collected data on three categories of CoEs - Basic and Strategic Research Template, Innovation and Advanced Technological Development Template, and Social and Economic Development Template. The template investigate the strategic orientation of each CoE, institutional support and operational conditions, and capacity building and impact.

(iv) **STEM input-output Matrix** (Annex 1) looking at enrolment and progression figures, investment, and infrastructure

### 3.3 Time Scheduling and Field Itinerary

This assignment is scheduled to take 2 months of study starting August 15, 2014. The Matrix 3 is a summary of the activities planned for this period.

Matrix 3: Time scheduling and Itinerary

| Task | Work Days | Dates |
|---|---|---|
| Debriefing, Literature Review and Inception Report | 5 | August 15-19, 2014 |
| Inception Meeting Entebbe | 2 | August 20-21, 2014 |
| Field Investigations | 32 | August 24-September 25, 2014 |
| Data Analysis | 5 | September 26-30, 2014 |
| Draft Report | 5 | October 1-7, 2014 |
| Validation Workshop | 2 | |
| Final Report | 5 | |
| Total | 56 | |

**Field Itinerary**

| Location | Dates |
|---|---|
| Arusha: Debriefing | August 15-17, 2014 |
| Kampala: Inception Report, Contract and agree on field logistics | August 20, 2014 |
| Burundi | August 24-29, 2014 |
| Rwanda | August 30-4 Sept, 2014 |
| Uganda | Sept 5 - Sept 8, 2014 |
| Tanzania | September 9 - 18, 2014<br>Zanzibar 9-10<br>Dar 11-12<br>Morogoro 14-16<br>Arusha 16-18 |
| Kenya | September 18-25, 2014<br>Eldoret 19-21<br>Nairobi 22-25 |
| Kigali Stakeholders Briefing Meeting | September 29, 2014 |

### 3.4 Resource Requirements

Resources into this assignment will include 58 person days and 32 Field days @ IUCEA rate in per diem, air tickets to and from Partner States and within (Tanzania and Kenya), local transport (taxi) in the field.

- We understand that IUCEA will procure air tickets directly.
- From our past experience, we are also aware that IUCEA will be making per-diem payments as the assignment starts. We are also aware that we shall request refund for taxi fare on return from the field.
- As has been the practice Fees/Remuneration for the study shall be paid straight into our office account on completion of the study.

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## ANNEX 1: COUNTRY POLICY AND INSTITUTIONAL ASSESSMENT MATRIX

To be completed by representatives of Government, Higher Education Institutions, Research Institutions/Organisations, and the business enterprises.

**Template 1a: Research and Innovation - Policy, Legal and Regulatory**

Country ..... Institution ..... Enterprise .....

Person Responding ..... Designation .....

| Policy Instrument | Central Issues | Comments |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**Template 1b: Research and Innovation - Institutional and Human Capital**

Country ..... Institution ..... Enterprise .....

Person Responding ..... Designation .....

| Strategic Focus | Last Five Years | | | Researchers Involved | | |
|---|---|---|---|---|---|---|
| | Number Projects | Projects Completed | Total Funding USD | PhD | Masters | Other |
| | | | | | | |
| | | | | | | |
| | | | | | | |
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**Template 2 (a) : STEM Policy and Institutional**

Country..... Ministry ..... Institution .....

Person Responding ..... Designation .....

| Policy/Rule | Number of Institutions | Central Issues | Comments |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**Template 2(b): Student Enrolment and Progression - STEM**

Country .....

Person Responding ..... Designation .....

| Subject Area | Enrolment by Level of Education and Gender | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **ECDE** | | **Primary** | | **Secondary** | | **Middle College** | | **Bachelors** | | **Masters** | | **PhD** | |
| | M | F | M | F | M | F | M | F | M | F | M | F | M | F |
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**Template 2c Infrastructure: Schools, Colleges , HEIs and Research Organisations Providing STEM**

Country .....

Person Responding ..... Designation .....

| **STEM Area** | **Number of** | | | | |
|---|---|---|---|---|---|
| | **Secondary Schools** | **Colleges** | **HEI** | **Research Organisation** | **Other** |
| | | | | | |
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Template 2d Number of Research organisations , Personnel and Funding

Country .....

Person Responding ..... Designation .....

| | Basic and Strategic | | | Innovation and Advanced Technology | | | Social and Economic Development | | | Other | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | HR | Fund | No. | HR | Fund | No. | HR | Fund | No. | HR | Fund |
| Public | | | | | | | | | | | | |
| Private Sector | | | | | | | | | | | | |
| HEI | | | | | | | | | | | | |

# ANNEX 2

## Research and Innovation Management Typology to Guide Country Discussions and Consultative Meetings at Partner State Level

Understanding the overarching policy goals of the national government is the fundamental requirement for effective leadership and management of research and innovation at an institutional level. For purposes of this study we identify six broad themes to guide country studies, on the strategic options for addressing current policy gaps in research and innovation management. We also propose to use these themes as the basis for discussions at the Consultative Meetings with Partner State governments, business, research and academic institutions.

Typology Research and Innovation Management

| Theme | Key Elements |
|---|---|
| **Leadership in Research and Innovation by government.** | • national policies on research and innovation<br>• governance structure of research and innovation<br>• approaches for human resource development in research and innovation<br>• funding allocations and instruments applied and communicated to public research organisations<br>• legal frameworks for research ethics. |
| **Leadership of Research in Institutions.** | • Institutional governance, including:<br>➢ developing a vision and a timeframe, designing feasible and achievable strategies,<br>➢ designing a performance framework for the institution, and establishing a process for reviewing the plan over time,<br>➢ the development of a critical mass of researchers, research infrastructure,<br>➢ delegation to senior members of the management team, and<br>➢ risk management.<br>• Awareness of the R&I setting including analysing the external environment and the role of the institution, taking account of key matters such as global research trends, policy settings and funding sources, the institutions comparative advantage and communication with staff and governments<br>• Establishing a research culture and ethos, including the development of a strong research culture, hosting leading researchers from other countries, providing support staff, and developing and implementing incentives and rewards for positive performance consistent with the goals of the institution. |
| **Management to Support Leadership of Research in Institutions.** | • Organisational structure, including creating a critical mass of researchers, interdisciplinary support, practical issues such as space, infrastructure and other academic obligations, provision of effective management and administrative support to the research groups, and support for colleagues in positions of responsibility.<br>• Executive and management operations, including ensuring roles are clearly defined and without duplication, and ensuring co-ordination in support for the implementation of the institutional plan.<br>• Committee operations, including the balance between purpose, frequency and effectiveness of the group. □ Research management and administration, including research support, research translation/commercialisation, financial management, asset management and performance data recording and analysis. |
| **Leadership of Researchers in Institutions.** | • Research students, postdoctoral and newly independent researchers, including staff appointments, staff developments, conditions of employment and performance management, assurance of the relevance and the quality of the research |

| | |
|---|---|
| | training and the research environment, and understanding the attitudes of younger generations.<br>• Development of research leadership including co-ordination of activities, selection of people, assembling teams, motivating workers, resolving problems, creating a supportive environment, communication, and providing focus and leadership reward systems that are both fair and capable of motivating excellence, and of attracting and retaining the best people, resource management and identification and support for emerging areas of strength and advantages. |
| **Management to Support Leadership of Researchers.** | • Research student management, including ensuring the relevance of their contribution to external policy settings, establishment of enrolment requirements, student induction, supervision arrangements and training, research methods and intellectual property (IP) management, training programmes for research methods, support for travel and conference attendance, support for secondment to industry, monitoring progress and support, examination process, and graduation confirmation.<br>• Staff management, including position descriptions, setting performance expectations, responsibilities and accountabilities, process for recruitment, selection and appointment of staff, contract arrangements, advising on research integrity, staff development, assisting and management conflict resolution, data analysis for trends in personnel profiles, supporting and managing staff surveys and feedback options, strategy, and management support for workplace change. |
| **Personal Behaviours and Qualities of Research Leaders and Managers.** | • Behaviour of leaders, including clear performance expectations, transparent and rigorous incentive systems, recognition and reward, provision of feedback, transparent and consistent decision making, dealing effectively with misconduct, provision of development opportunities, rewarding and celebrating individual and team successes, delegation, communication, and being available to provide advice and assistance.<br>• Personal qualities of leaders, including acceptance of the responsibility and accountability that comes with the role of being a leader, recognition and appreciation of teamwork in leadership and management, soliciting and accepting personal feedback on personal performance and the performance of the senior team, communicating with empathy, adapting to changing circumstances, advocating with passion, and demonstrating honesty and integrity. |

## Annex 3: RESEARCH AND INNOVATION HUBS TEMPLATES

### Characteristics

| Basic and Strategic Hubs | Innovation and Advance Technology Development Hubs | Social and Economic Development Hubs |
|---|---|---|
| Focus: Human Capital and Basic Research Infrastructure<br>• Support for frontier fields of science and international competitive research capabilities<br>• connect researchers across fields and geographical locations<br>• support for multi/inter-disciplinary research<br>• connect science to international research networks<br>• support scientific prioritization in the science system | Focus: Product Development<br>• support strategic and applications oriented research and expertise<br>• bring together the complementary resources needed for technical and industrial development for product development, processes and services | Focus: Policy and Improving Human Resource<br>• social and economic issues of national importance<br>• generating human resource capacity<br>• stimulating specilisation and competence in higher education<br>• stimulating academic -industry collaboration |

## Template 1: Basic and Strategic Research

**Scheme/Centre ..... Location .....**

**Budget USD ..... Researchers PhDs ..... Masters ..... Other .....**

**Person Responding ..... Designation .....**

| Strategic Orientation | Institutional Supporting and Operational Conditions | Capacity Building and Impacts |
|---|---|---|
| | | Resource Creation |
| | | Resource Collaboration |
| | | Research Capacities |
| | | Socio-Economic and Development |
| | | Training and Skills |
| Comments | | |

## Template 2: Innovation and Advanced Technological Development

**Scheme/Centre ..... Location .....**

**Budget USD ..... Researchers PhDs ..... Masters ..... Other .....**

**Person Responding ..... Designation .....**

| **Strategic Orientation** | **Institutional Supporting and Operational Conditions** | **Capacity Building and Impacts** |
|---|---|---|
| | | Resource Creation |
| | | Research Collaboration |
| | | Research Capacities |
| | | Socio-Economic and Development |
| | | Training and Skills |
| | | Internationalisation |
| Comments | | |

## Template 3: Social and Economic Development

**Scheme/Centre ..... Location .....**

**Budget USD ..... Researchers..... PhDs ..... Masters ..... Other .....**

**Person Responding ..... Designation .....**

| **Strategic Orientation** | **Institutional Supporting and Operational Conditions** | **Capacity Building and Impacts** |
|---|---|---|
| | | Resource Creation |
| | | Research Collaboration |
| | | Research Capacities |
| | | Socio-Economic and Development |
| | | Training and Skills |
| | | Networking and Partnerships |
| | | Technology and Innovation |
| | | Knowledge Sharing |
| Comments | | |