Review and Evaluation of the Performance of Tanzania's Higher Education Institutions in Science, Technology and Innovation

FINAL REPORT

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Abbreviations

ACBF	African Capacity Building Foundation
AERC	African Economic Research Consortium
ADB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
APIF	African Policy Institutes Forum
ARU	Ardhi University
ASDP	Agricultural Sector Development Program
CAADP	Comprehensive African Agriculture Development Program
CARMATEC	Centre for Agricultural and Rural Mechanization and Technology
CBE	College of Business Education
COBET	Complementary Basic education in Tanzania
CoET	College of Engineering and Technology
COMESA	Common Market of Eastern and Southern Africa
COSTECH	Tanzania Commission for Science and Technology
CTI	Confederation of Tanzanian Industries
DIT	Dar es Salaam Institute of Technology
DUCE	Dar es Salaam University College of Education
EAC	East African Community
EPRC	Economic Policy Research Centre
ESDP	Education Sector Development Program
ESMIS	Education Management Information Service
ESRF	Economic and Social Research Foundation
ETP	Education and Training Policy
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GER	Gross Enrolment Ratio
GoT	Government of Tanzania
HEDP	Higher Education Development Program
HEI	Higher Education Institution (s)
HELSB	Higher Education Student Loans Board
HIV	Human Immuno-deficiency Virus
HKMU	Hubert Kairuki Memorial University
IAA	Institute of Accountancy Arusha
ICT	Information and Communications Technology
IDRC	International Development research Centre
IFM	Institute of Finance Management
IHI	Ifakara Health Institute

IJMC	Institute of Journalism and Mass Communication
ILO	International Labour Organization
IMTU	International Medical and Technological University
IPAR	Institute for Policy Analysis and Research
IPR	Intellectual Property Rights
ISO	9001 International Standard Organization (Quality Management System)
ISO 14001	ISO standard for the Environmental Management System
ISS	Institute of Social Studies
JAST	Joint Assistance strategy for Tanzania
MAFSC	Ministry of Agriculture, Food Security and Cooperatives
MCST	Ministry of Communications, Science and Technology
MDG	Millennium Development Goals
MEM	Ministry of Energy and Mines
MEVT	Ministry of Education and Vocational Training
MHEST	Ministry of Higher Education, Science and Technology
MHSW	Ministry of Health and Social Welfare
MID	Ministry of Infrastructure Development
MIST	Mbeya Institute of Science and Technology
MITM	Ministry of Industry, Trade and Marketing
MoEVT	Ministry of Education and Vocational Training
MLEYD	Ministry of Labour, Employment and Youth Development
MLHHSD	Ministry of Lands, Housing and Human Settlements Development
MU	Mzumbe University
MUCCOBS	Moshi University College of Co-operative and Business Studies
MUCE	Mkwawa University College of Education
MUHAS	Muhimbili University of Health and Allied Sciences
MKUKUTA	Mkakati wa Kuondoa Umasikini na kukuza Uchumi Tanzania (Strategy for Growth and the Reduction of Poverty)
MKUZA	Mkakati wa Kuondoa Umasikini Zanzibar (Strategy for Growth and the Reduction of Poverty in Zanzibar)
NACTE:	National Commission for Technical Education
NBS	National Bureau of Standards of Tanzania
NEMC	National Environment Management Council
NEPAD	New Partnership for Africa Development
NFAST	National Fund for Advancement of Science and Technology
NGO	Non Governmental Organization (s)
NQF	National Qualification Framework
NSGRP	National Strategy for Growth and Reduction of Poverty
NSRC	National Scientific Research Council
OECD	Organization of Economic Cooperation and Development
OPRAS	Open Performance Review and Appraisal System
OUT	Open University of Tanzania
PEDP	Primary Education Development Program
PPP	Public Private Partnership
QA	Quality Assurance
QAS	Quality Assurance Systems
R&D	Research and Development
R&I	Research and Innovation
S&T	Science & Technology
SADC	Southern Africa Development Community
SAUT	St. Augustine University of Tanzania
SEDP	Secondary Education Development Program

SME	Small and Medium Enterprises
STI	Science, Technology & Innovation
SUA	Sokoine University of Agriculture
SUZA	State University of Zanzibar
SWOT	Strengths, Weaknesses, Opportunities, Threats
TACRI	Tanzania Coffee Research Institute
TAKNET	Tanzania Knowledge Network
TAS	Tanzanian Shilling (1 US$ = 1,980 TAS in 2010)
TATC	Tanzania Automotive Technology Centre
TANGO	Tanzanian Association for Non Governmental Organizations
TBS	Tanzania Bureau of Standards
TCRA	Tanzania Communication and Regulatory Authority
TCU:	Tanzanian Commission for Education
TDMS	Teacher Education Development and Management Strategy
TDTC	Technology Development Transfer Centre, University of Dar es Salaam
TDV	Tanzania Development Vision 2025
TEA	Tanzania Education Authority
TEMDO	Tanzania Engineering and Development Organization
TFDA	Tanzania Food and Drug Authority
TIA	Tanzania Institute of Accountancy
TIE	Tanzania Institute of Education
TIRDO	Tanzania Industrial Research and Development Organization
TRIPS	Trade Related Aspects of Intellectual Property Rights
TTI	Teacher Training Institute
TTI	Think Tank Initiative
UDOM	University of Dodoma
UDSM	University of Dar es Salaam
UNESCO	UN Educational, Scientific and Culture Organization
UNDP	UN Development Program
UNFPA	UN Population Fund
UNIDO	UN Industrial Development Organization
URT	United Republic of Tanzania
VETA	Vocational Education Training Authority
WB	World Bank

Executive Summary

Acting on the request of the Tanzanian Government, UNESCO has set to conduct a Review of Higher Education Institutions (HEI) with the main purpose of determining their performance in science, technology and innovation (STI) and their wider contribution to strategic development plans.

The review process was carried out by examining a large set of documents and papers prepared by national and international experts, the execution of a fact finding mission in the month of September, 2010, personal consultations with national and international experts on the country, the execution of a limited survey among key stakeholders in the STI and education systems, and the execution of a validation workshop of the Draft Report. This **Report** describes the main findings and outcomes, and provides recommendations for action to be inserted into the definition of a future Roadmap.

The Review is expected to provide inputs to ensure that the policies and programs of Tanzania's HEIs in science, technology and innovation are efficient and effectively aligned to address national development priorities as identified in the existing national strategies and vision documents. The Review should also enable the Government to monitor progress in its educational reform program, make adjustments where necessary and ensure that any future changes to Government's science, technology and innovation and HEI policy are informed by the findings.

The development of a framework for the analysis of the performance of HEI in STI has followed a system's approach, which should not be taken as a blueprint for how to organize these processes, but rather as a way to explain their behaviour and future development under the specific context of Tanzania. Such approach is a powerful instrument to understand and to orient policies to promote learning, innovation and competence building processes.

The systems approach has contributed to the understanding that both technology based and non-technology based innovations do not follow a linear path that begins with research, moves through the processes of development, design, engineering, production, and ends with the successful introduction of new products and processes into the market, but rather, that it is an interactive (and cumulative) process that involves continuous feedback loops between the different stages and between many actors, including companies, universities and research organizations.

Moreover, the approach has also permitted to identify major shifts in the diffusion and production of technological knowledge, due to the increasing importance of collaborative networks and the growing extent to which actors need to cooperate more actively and more purposefully with each other in order to cope with increasing market pressures in a globalizing world, phenomena that has lead to the paradigm of open innovation.

Different authors have discussed what should be understood by innovation in developed and developing countries. Independent from the outcomes of the several arguments that have been put forward, it is to be noted that even minor or incremental innovations or more simple adaptation which are more common in developing economies, result from a process of learning in an organization, which is neither automatic nor effortless, and these require a spectrum of skills, knowledge and capacities for searching, selecting, assimilating and adapting techniques. Developing and maintaining these capacities requires both a conscious effort and in many cases the investment of significant resources.

The STI system is also experimenting transformation and restructuring, based on the advances and visions of open innovation, online social networks and web 2.0, and there is a

greater possibility of new interaction-based approaches to support national innovation activities. Called now the national open system of innovation, the new system generation is an effective and comprehensive open innovation structure, and it can be argued that a Complex System of Innovation can be defined, and STI policies should be considered as interventions in this system.

The STI system contains a heterogeneous group of institutions and organizations one of which is higher education and universities. Universities are complex social organizations that produce teaching, research and "public goods" for individual and collective consumption in all areas of human endeavour. Such services are delivered to private, non-profit and public sector individuals and organizations. All the categories of services provided by universities play an increasingly important role in the STI system, in step with the growing importance that knowledge now plays in the path towards the "knowledge economy"; they are thus major actors in the system. The interlinked roles of education, research and innovation must be acknowledged not only as a core condition for the success of a development strategy, but as part of the wider move towards an increasingly global and knowledge—based economy.

The performance of Tanzanian HEI in STI can be determined within the above context. At the onset of the analysis, it may be said that Government in consultation with society has defined an important set of national development policies and strategies, in order that the country attains the Millennium Development Goals and other developmental objectives. It has defined as well, a set of STI policies and strategies, accompanied by policy destined to the improvement of higher education.

The achievements that can be observed in the implementation of the different policies adopted throughout the years have been more the exception than the rule. This Review's findings show that the performance of HEI in STI can be best characterized by an environment where there exists policy instruments related to the development and finance of the traditional tasks of HEI, training, research and extension, but that there is also indifference to research in the institutional context as well as resistance to changes in the institutional culture.

The above can be attributed to a weak recognition of research in the normative architecture, which has a strong administrative bias, and the still limited existence of funding, human resources and equipment. Only more recently there is better motivation of the research community and lines of research are being drawn based on national priorities. The weak recognition of research and extension produces discrimination or lack of incentives for active researchers, which are few in number and many are self-made.

The situation is also characterized by a not very significant scientific production, at the international levels, and a weak relationship between research and postgraduate studies, which has led to a lack of recognition and credibility of HEI on behalf of external academic and development agents. Also, the quality and relevance of the research that is undertaken, discourages policymakers and private sector from using local research outputs and prompts them to seek research findings from abroad. To ensure research effectiveness, performance monitoring and quality assurance, a system has to be in place. There exists neither institutional nor national mechanism for assessing research performance by stakeholders in the country.

Finally, there are only limited efforts in attracting the private sector, individuals, business people, trade unions and community organizations into contributing significantly to the national STI effort by the way of funding or shared sponsorship of research programs.

Additionally, the STI policy needs to advocate for regional and international collaboration in STI funding as well.

All HEI and STI stakeholders in Tanzania agree that it is necessary to increase the number and the quality of the human resources in STI, both in the public and private sectors; it is necessary to increase the public budget destined to the HEI, and it is necessary to increase the infrastructure capacities of HEI. These three large and fundamental needs represent the base on which it is possible to improve and enhance the performance of HEI in STI. It is a political decision that will support all other actions that can take place.

The main recommendation that this Review can make, following the analysis of the situation, the examination of policy and strategic documents, in particular the latest STI Policy (under review) and the Higher Education Development Programme (HEDP), is that Tanzania requires a Roadmap which is realistic and clearly recognizes what can really be done in the short and long-terms. Extensive and overoptimistic lists of objectives and goals, in overlapping policies, weak coordination mechanisms, little funding, a disarticulated STI system, weaknesses in human resources and other limitations, cannot lead the country into an effective capacity building process of its HEI and STI systems.

Following the above vision, a platform for a Roadmap is proposed, emphasizing eight policy objectives for research and extension, the latter understood more amply as the "third mission" of the university. Although all objectives are of key importance, it is highlighted that coordination and networking and the creation of an open forum for research and innovation can be the guiding efforts to improve the performance of HEI in STI. The eight proposed policy objectives to lead the Roadmap are:

- To improve the quality in the education and training of students and develop a critical mass of a well trained human resource base.

- To complement existing research capacities among HEI and with those of government and other public and private institutions.

- To develop associative capacities in research through different forms of association, privileging the creation of national and participation in international networks.

- To fulfil the "third mission" of the HEI by creating open research and innovation forum, as an open platform, based on the idea that in a world of distributed knowledge, enterprises and research organizations benefit mutually and learn one from each other, allowing technology transfer.

- To understand and define actions related to brain drain, brain gain, and brain circulation.

- To promote and create new postgraduate studies including STI management.

- To increase and maintain constant Government´s financial support of STI

- To identify research areas, including actions to define research activities around available traditional knowledge.

Within this framework, the results and guidelines for a Roadmap given in the Review should inform, complement or enrich the High Education Development Strategy, and it is proposed that the Review and the HEDP be integrated into a single new strategy.

Introduction

In July 2007, the President of the United Republic of Tanzania requested UNESCO's Director General to assist Tanzania to reform and reposition the country's science, technology and innovation (STI) system in a way to enhance the contribution of the sector to the national economic development. As part of this initiative a number of activities and programs are being executed or planned by UNESCO and the Ministry of Communication, Science and Technology (MCST).

The Higher Education system is one of the areas being assessed in terms of evaluating and streamlining current policies and programs in science, engineering, technology and innovation in relation to their contributions to national economic development. The system includes universities as the key Higher Education Institutions (HEI), which is the main (but not necessarily the exclusive) objective of this Review.

The Terms of Reference for the present Review has included a number of initiatives:

- A comprehensive evaluation of the performance of HEIs in Science, Technology and Innovation (STI) and their contribution to national economic development; considering that innovation is also non-technology based, the evaluation includes the social sciences, in particular management and economics

- Development of a national strategy on research and training programs for HEIs in STI in relation to their contribution to the existing national development strategies.

- A set of recommendations for the establishment of a high level taskforce to examine the scope for closer collaboration between universities and the productive sector.

Under this framework the Review is expected to provide inputs to ensure that the policies and programs of Tanzania's HEIs in STI are effectively aligned to and address national development priorities as identified in the existing national strategies and vision documents. For this purpose, the evaluation is made within a conceptual framework of a national science, technology and innovation system and which can also serve as a guide for the definition of future STI policies.

More particularly the evaluation has set to assess the current programs and policies in higher education, science (including selected social sciences) engineering, technology and innovation and their effectiveness in meeting the development goals of government as spelled out in national strategy documents on development, namely the achievement of:

- A full understanding of the development of innovation and the increasing complexity of innovation and innovation systems.

- Connections between science, engineering, technology and innovation programs and curricula in HEIs and the national development strategies;

- Capacities (staff and infrastructure) for meeting the challenges of training and research in science, engineering, technology and innovation and linkages with the productive sector;

- Qualities and performance of students in science, engineering, technology and innovation related courses;

- Level of connections within the university research system and between it and the national innovation system;

- Status of institutional management of research;

- Status of research training environment with special attention to gender issues; and

- Programs for the integration of science, engineering, technology and innovation into goals of national development strategies.

The Review has also searched for the effectiveness of some key principles of the role of HEIs in national development, namely:

- Excellence

- Gender equality

- Usefulness of programs in relation to national development goals

- Student choice

- Linkage and collaboration with productive sector

- Evidence of contribution or non-contribution of HEIs to science, technology and innovation programs to the national economy through limited tracking.

- How can STI policies and strategies and higher education policies and strategies be embedded realistically and effectively into the national development plans

The evaluation has addressed the efficiency of the existing administrative arrangements and the performance of research and training programs. With respect to the accepted universal benchmarks, the evaluation was expected to assess the validity of current research performance indicators, their weightings in the performance formulae, their effect on particular disciplines, universities and student groups, and the effectiveness and impact of the current training and research programs.

The Review/evaluation of the performance of HEIs in Science, Technology and Innovation and their contribution to national economic development should enable the Government of the United Republic of Tanzania to monitor progress in its educational reform program, make adjustments where necessary and ensure that any future changes to Government science, engineering, technology and innovation HEI policy are informed by an analysis of the evaluation's findings.

The work plan for the review included an extensive analysis of existing literature, government documents, university publications prepared by both national and international experts; the execution of a working mission that took place in September of 2010, the execution of a limited survey addressed to key stakeholders in the science, technology and innovation and education system. It was also envisaged that a **Consultation Report** would be produced and be presented and delivered to Government between December 2010 and January 2011. The change of Government in late 2010 prompted the authors of the Review to delay the previous dates until the first semester of 2011, to allow the new authorities to have the opportunity to receive and comment on the findings of the Review.

A draft **Consultation Report** was submitted on 25 March 2011, and on 15 June 2011 a validation workshop was convened by the Tanzanian Commission of Universities, which was attended by key science and education specialists, who produced several recommendations to improve the said draft.

The present document constitutes the **Final Report** of the Review and contains in **Chapter 1** a conceptual (and operative) framework for the STI system, which set the base for the Review. The framework contributes in assessing how STI policies have been defined and implemented, as well as the results obtained, and to what extent these have followed or have been embedded into national development plans. The framework highlights the role of higher education institutions in STI.

Chapter 2 provides a brief overview of the social and economic situation of the country and of some of the more important existing development plans. In the latter, the expected role of STI or HEI is sought and highlighted when it exists. This Chapter also includes a view of the external situation that affects the country and in particular the international or regional trends that impact on the STI system. This overview does not substitute an in-depth trend analysis that needs to be made in the future, which is not the objective of this Review. From such a trend analysis and the scenarios that could be derived further opportunities and threats to the development of Tanzania projected to the longer term can be better defined.

Chapter 3 provides an overview of the national STI system in the perspective of the developed framework. Some key issues such as governance (institutions and policies) and research and development in key strategic sectors are reviewed here. Such overview dos not replace an in-depth analysis that is required, as will be discussed in the conclusions and recommendations of this Review. Further, much of such analysis will be conducted in 2011 by an OECD led review.

Chapter 4 is dedicated to a description of the education system and very particularly higher education. It reviews different issues, in particular the current Education Policy and how it helps or hinders the articulation of the programs of STI in the Higher Education Institutions (HEI) and takes a glance at the educational level that prepares students to enter to study subjects at these HEI as a prima facie reason for the performance with respect to their contribution to development A more detailed analysis is conducted on the Higher Education Development Program now in its way to implementation.

Chapter 5 provides the main conclusions reached in the analysis, it incorporates the results of a Mission that took place between the 20th and 24th of September (Annex 1 contains the list of institutions and persons visited) and of a limited survey sent to about 70 national experts. Specific recommendations are drawn from this set of conclusions

The conclusion includes, among others, the linkages of the HEI with the other actors of the STI System. It is also a more detailed mapping of the academic system. Some issues also highlighted include the accreditation status; financial models underlying the functioning of universities; universities as service providing institutions; differences in structure and behaviour across universities; a further look into research-oriented universities: comparative perspective; and alternate patterns of university behaviour.

The results presented in this Chapter have been greatly enriched by the conclusions reached at the Validation Workshop mentioned above.

Chapter 6 defines the way recommendations may be put into execution in order to improve the performance of HEI in STI, in the way of a Roadmap. It is to be noted that such a "Roadmap" is expected to be composed of simple but effective and realistic steps towards the improvement of this performance, and should replace the extensive and overoptimistic plans and strategies that have been defined but have little or no implementation so far.

This given guidelines for a Roadmap in the review should inform, complement or enrich the High Education Development Strategy, and it is proposed that the Review and the HEDP be integrated into a single new strategy.

Chapter 1

The Science, Technology and Innovation System of Tanzania: A framework for analysis

1.1. The Science, Technology and Innovation System of Tanzania: A framework for analysis

The development of a framework for the analysis of the performance of HEI institutions in science, technology and innovation will follow a system's approach. This approach should not be taken as a blueprint for how to organize these processes, but rather as a way to explain their behaviour and future development under the specific context of Tanzania.

Lastres and Cassiolato (2007) provide six reasons as to why the innovation (or science, technology and innovation)/ [1] system approach is a powerful instrument to understand and to orient policies to promote learning, innovation and competence building processes:

- Helps to overcome the limitations of the focus on individual organizations, sectors, clusters and space as analytical and intervention units.

- Covers economic, political and social contexts and the cognitive environments, where the main processes of learning, capacity building and research and innovation take place and where tacit knowledge flows.

- Offers a broader understanding about the possibilities of acquiring and using technologies.

- Helps avoiding two important traps: of dissociating economic and social development and of adopting a supposedly automatic selection of cases to be supported.

- Does not dismiss the possibility of using research and innovation policies to reduce regional and social inequalities.

- Represents an important conceptual basis for guiding research and innovation policies in all countries and particularly the least developed.

Following Dantas (2005) there are several ways in which the system approach can guide policy:

- It helps to shift the focus of policy from individual organizations to them plus their interactions. Some of these interactions can involve various organizations engaged in the production of knowledge such as companies (users, suppliers or competitors), universities and research institutes and those promoting learning, including policy organizations and relevant stakeholders.

- It shifts attention from strictly S&T inputs, such as research, to innovation processes and outcomes, in other words to the processes involved in the introduction of new products and methods to a particular economy or firm.

/ [1] The use of the term innovation system or science, technology and innovation system, or research and innovation system, depends on the emphasis that needs to be given to the corresponding process, understanding that they should co-evolve if the system will behave appropriately. For the case of Tanzania, the term science, technology and innovation system will be used.

- It helps to shift the emphasis of policy away from deciding on whether to support the supply or the demand for science and technology, and towards issues that affect the interaction between the supply and demand of knowledge.

- It acknowledges the behaviour of both firms and science and technology organizations (universities, research organizations or technological centres) to be influenced by a wide range of institutions and supporting organizations, such as for example those concerned with standards, certifications or patents.

- It acknowledges that analysis as interventions to support research and innovation can operate at many levels of the economy. In fact, sector (technology fields or product areas), multinational, regional, national and local systems, have also been defined and described.

The systems approach to STI was developed in the early 90's in the developed countries, as a way to better describe the innovation process as the key determinant of productivity and competitiveness gains, and thus of economic growth. In its early years, attention was paid on national institutional settings as determining innovation performance, more recently there has been a shift towards the specific conditions in different sectors and technology areas as determinants of the research and innovation performance.

The systems approach has contributed to the understanding that technology based innovation does not follow a linear path that begins with research, moves through the processes of development, design, engineering, production, and ends with the successful introduction of new products and processes into the market, rather, it is an interactive (and cumulative) process that involves continuous feedback loops between the different stages and between many actors, including companies, universities and research institutes.

In discussing research and innovation, it is key to bear in mind that innovation is not just technology based, in fact, innovations in business models, organizational design and functional strategies, are also critical for success. Moreover, it is discussed today that there are a large number of initiatives that have disrupted existing modes of production and innovation, for example in the environmental area, or micro financing, which are prominent in most developing countries (Hall, 2010).

In recent years, the nature of innovation has been changing, as there have been major shifts in the diffusion and production of technological knowledge, due to the increasing importance of collaborative networks in the process of knowledge creation. A key element of the current phase of the knowledge-based economy is the growing extent to which actors need to cooperate more actively and more purposefully with each other in order to cope with increasing market pressures in a globalizing world, liberalization of markets, new technologies and changing patterns of demand.

Recognizing the above changes, a paradigm of "open innovation" has been defined (Chesbrough et al, 2006), this paradigm assumes that internal research is no longer an invaluable strategic asset; in the traditional model of innovation, firms relied on the assumption that innovation is a process that needs to be controlled by them, however changes in society and industry have led to the mobility of knowledge and the development of new financial structures such as venture capital, forces that have moved the boundaries of the innovation process. It has been noted by many authors (f.e. Gastrow, 2009) that the literature addressing open innovation has a focus on developed economies and that new approaches are needed to better understand the new phenomena in developing economies.

Different authors have discussed what should be understood by innovation in developed and developing countries. In the former, innovation has been mainly considered as a major

change in how processes are organized and how products work (radical innovations), while in developing environments the key concept is incremental innovation (minor modifications to products and processes), which often emerge from the experience of making and delivering products. The question of incremental innovations is of course not just a preserve of developing countries, in fact 85 to 90 percent of the average development portfolio of developed country firms is made up of such innovations, which are necessary for continuous improvement, but don't change the competitive balance or contribute much to profitability (Day, 2006).

It is relevant here to note that even incremental innovations or more simple adaptations result from a process of learning in an organization which is neither automatic nor effortless. Even minor innovations require a spectrum of skills, knowledge and capacities for searching, selecting, assimilating and adapting techniques. Developing and maintaining these capacities requires both a conscious effort and in many cases the investment of significant resources (Albu, 1998).

Several definitions of national innovations system or national science, technology and innovation system have been advanced (Aguirre-Bastos and Seidl-da-Fonseca, 2005), the basic idea being the existence of a "system" that is capable of promoting and supporting the production of innovations. Independent of the definition that is used and as already discussed above, the system's approach provides the framework within which Governments can form and implement policies to influence the research and innovation processes.

Weber (2010) has discussed a more ample definition of STI system, as that composed of heterogeneous agents (organizations and individuals) that are characterized by specific learning processes, competencies, goals, organizational structures and behaviours and interact through processes of communications, exchange, cooperation, competition and command connected in various ways through market and non-market relationships, that generate innovations and commercialize them. Figure 1 depicts such a conceptual definition.
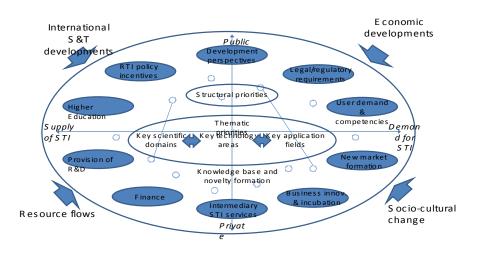
Figure 1: The STI System

Source: Weber, 2010

Weber has also discussed that operatively the existence of the STI system has a role to play in society and the economy, namely to enable discovery, novelty creation and change, in order to fuel economic development and to respond to widely perceived needs and demands from society. Further the STI system needs itself to be able to respond to changes, pressures and opportunities that occur in the context, like new scientific discoveries, socio-cultural changes or new priorities defined in competing economies.

In this concept, the demand side is given a prominent role, as it is also made up of heterogeneous agents made up of buyers, individual consumers, firms and public agencies, again each characterized by their specific knowledge, competencies and goals, and affected by emerging trends, trend-breaks, social factors and institutions. Thus, in the STI system the demand is characterized by the interactions of the various agents with producers and these interactions are shaped and transformed by institutions.

There are several functions that can be recognized in such a system, which include:

- Higher education and competence development
- Provision of research
- Finance
- Intermediary STI services and consultancy
- Business innovation fabric and incubation
- New market formation
- User demand and competencies
- Legal and regulatory requirements
- Development perspectives
- Research, technology and innovation policy incentives and coordination

As already mentioned, the approach to STI system originates in developed countries, where there exist distinct capabilities to create innovations and the skills needed to bring about technological change. In the case of developing countries, the differences with the developed countries are sometimes enormous hence it is considered that the STI system should play a different role, mainly as a strategic management tool for catching-up, which is in fact the common focus of industrializing economies (Gu, 1999). In developed countries, the approach almost takes for granted there is a knowledge base, which is of course only an objective to be reached in the developing ones, as is the case of Tanzania.

The STI system is also experimenting transformation and restructuring, based on the advances and visions of open innovation, online social networks and web 2.0, there is a greater possibility of new interaction-based approaches to support national innovation activities. Called now the national open system of innovation, the new system generation is an effective and comprehensive open innovation structure. Science, technology and innovation systems can also be defined at the level of geographic entities like countries or regions, but equally with respect to sectors or technological areas.

Aguirre-Bastos and Fröhlich (2009) have argued that due to the increasing complexity of the innovation process, a Complex System of Innovation can be defined, and STI policies should be considered as interventions in this system. The approach towards understanding innovation processes from a systems perspective has also been discussed by Beroggi et al (2005). In this latter case it is recognized that a new set of statistical indicators are needed to measure and optimize innovation efforts on a cross national economic scale.

When a traditional approach is used it must be considered that the STI system requires that many elements (institutions and organizations) and flows (information, knowledge and finance) of a complex system have to be in place, something that does not happen in many

developing countries where there exist serious systemic weaknesses (Mytelka and Oyeyinka, 2003).

Considering such systemic weaknesses and the lack of conditions that prevent these countries to generate new technology based innovations, many authors have questioned the existence of innovation systems or have suggested alternative approaches to describe existing mechanisms. Edquist (2001) for example has suggested the concept of "system of innovation for development (SID)", focusing on absorption capacities, and indicating four main areas of divergence from a "traditional" system:

- Product innovations are more important than process innovations because of the effect on the product structure.

- Incremental innovations are more important and attainable than radical ones.

- Absorption (diffusion) is more important than development of new innovations for the world.

- Innovations in low and medium technology sectors are more attainable than those in high technology systems.

Lall and Pietrobelli (2003) have proposed the concept of "national technology system", that considers the fact that most developing countries do not create new technologies, but do import, absorb, adapt and improve on them, and that such efforts are vital to their growth and competitiveness, and have systemic elements similar to those of the systems of innovation in more developed countries.

In this context, the following definition of STI system in developing countries has been advanced:

> "The network of functioning institutions, organizations and policies in the public and private sector, which interact constructively to facilitate learning, produce, import, modify, adapt, diffuse, transfer, and utilize knowledge, in the pursuit of a common set of cultural, environmental, social, and economic goals and objectives"

This definition avoids the idea of radical innovations or sole introduction of new technology-based products in the market, and recognizes that a different understanding of the role and characteristics of research and innovation can help redefining the national STI system in developing countries. It also serves to accommodate the idea of an open STI system. For developing economies, such as Tanzania, this concept leads also into a learning system stressing adaptation to local conditions, product/process improvement and systemic search for outside knowledge and skills, besides in-house knowledge development.

Within the above definition, it should be considered that the actions and interactions within the STI system and between STI system and context are shaped by institutions (including norms, established practices, rules, laws, standards, labour markets, etc.) on different levels (regional, national). What is important to take into account is that beyond geographically specific institutions, sectors, technological or thematically specific institutions do matter, they can constrain or enable the development of research and innovation in specific sectors (Weber, 2010).

To characterize the STI system more appropriately it is important to pay attention to the specific types of knowledge and technology that are produced. It is important to keep in mind that S&T knowledge is not confined to the knowledge generated by research organizations, but it comprises equally the knowledge of industrial knowledge producers and users, as well as final end-users of products and services.

Whatever change is produced or desired in the STI system will be the result of the co-evolution of its various elements including technology (science and technology drivers), skills (knowledge base, learning), demand (demand side drivers), structural change (firms, non-firm organizations and institutions). The process of co-evolution involves the aforementioned elements, i.e. knowledge and technology, firm and non-firm actors, their interactions and learning processes, it includes the demand side and the institutions that guide interactions. The STI system analyses thus need to focus on intertwined changes in relation to these elements.

1.2. Higher Education in the STI System

The STI system contains a very heterogeneous group of institutions and organizations one of which is higher education and universities. Universities are complex social organizations that produce teaching, research and "public goods" for individual and collective consumption in all areas of human endeavour. Such services are delivered to private, non-profit and public sector individuals and organizations. All the categories of services provided by universities play an increasingly important role within the STI system, in step with the growing importance that knowledge now play in the path towards the "knowledge economy" (Katz, 2009), they are thus major actors in the system.

The sustained development of Tanzania requires on one hand faster productivity growth and the strengthening of international competitiveness, and on the other facing key social challenges, also, the country requires improving its governance. All of these can be attained only on the basis of a much better trained labour force and significant improvements in equity of access and quality in higher education.

The production of highly skilled human capital is certainly the main contribution that HEI can make to the STI system. Efforts to upgrade the technological infrastructure and stimulate innovation will not yield a high return if it is not completed with and adequate stock of advanced human capital. It is well established that large increases in the supply of workers with university training in the 1970's contributed to the rapid technological change of the time and accelerated the demand for skills, this is the case of South Korea for example.

In order to reach the vision established for 2025 (URT, 2000)

> "… by then the economy will have been transformed from a low productivity agricultural economy to a semi-industrialized one, led by modernized and highly productive agricultural activities, integrated and buttressed by supportive industrial and service activities, a solid foundation for a competitive and dynamic economy with high productivity will have been laid".

Tanzania must move into a phase of technology deepening in its production structure and of more public goods production and dissemination in different areas, thus, the creation of new technological and institutional capabilities is a matter of State. Adequate macroeconomic management is important, but it is equally important to proceed with experimentation, learning and structural transformation at the micro and regional level, to create markets, institutions, domestic production and technological capabilities the country presently lacks.

The interlinked roles of education, research and innovation must be acknowledged not only as a core condition for the success of a development strategy, but as part of the wider move towards an increasingly global and knowledge—based economy. Further, rising demands for knowledge and highly skilled labour has changed the role of universities in many ways.

In an open STI system there are several preconditions for an efficient operation of HEI that must change. For example administrative regulations that hamper academic mobility;

procedures for recognition of qualifications for academic purpose which are at times lengthy, universities must accept that research is no longer an isolated activity and that the emphasis is shifting from individual researchers to team and global research networks. Scientific problems tend to go beyond traditional disciplinary structures and cutting edge research is increasingly being conducted at the interface between academic disciplines or in multidisciplinary settings. Universities research environments are more competitive and globalized and require greater interaction.

Besides teaching and research, universities are increasingly expected to make a direct contribution to economic development and the wellbeing of society. This role requires HEI not only to produce but also commercialize knowledge, i.e. to use research results to create intellectual property and contribute to new processes and products tradable in the market. Thus HEI must face this challenge by transforming incentives structures, engaging in public-private partnerships, establishing spin-off companies and patenting research results.

There are unrealized potentials for exploring university – industry collaboration that range from informal interactions to the establishment of new businesses. Formal relations (e.g. spin offs, patents, science parks) are most visible and therefore subject to considerable attention in policy. However, in many cases, informal contacts and contract research may correspond much better to the needs of industry. There are several reasons for this:

- Most knowledge requirements are specific, of limited scope and arise suddenly in the course of R&D.

- There is a considerable tacit and skill-based element in the expertise industry researchers seek and obtain when they interact with academia.

- Mutual respect and understanding are vital prerequisites for success in formal partnerships, and these are most easily built up informally.

The "third mission" of universities is often equated with knowledge transfer narrowly defined as licensing and commercialization of research. Within the STI system framework, this view needs to be broadened by exploring how the new roles of universities contribute to its operation. For example even if the economy see their challenge not in creating new technology, but transferring existing technologies, they cannot afford not to develop a domestic R&D base. Sufficient capacity is necessary to identify S&T options, to adapt them to local needs, and to create technologies unique to the country. As suppliers of advanced education and dominant players, universities play a central role in developing such capacity.

Strengthening cross-sector research collaboration is a matter of building trust, improving communication and strengthening incentives. One key obstacle is the lack of private sector confidence in the quality and the relevance of academic research. Stimulating excellence when funding research and, notably, changing incentives at the level of individual researcher goes along way addressing his challenge.

The established research and innovation agenda of Tanzania is proactive, promoting commercialization in the private sector, and in funding and stimulating applied research in universities. The changes that are taking place must draw on horizontally expanding capacities in higher education and research activities.

The importance of university education and research is particularly prominent in technology-based industries. Due to skill-based technology change, universities are becoming increasingly important also to other industries, traditionally not considered as knowledge-intensive. Evidence suggests that S&T policy can be effectively used to add value to traditional production. The perceived superiority of manufacturing compared to natural

resource-based activities has constrained many countries from realizing the full potential of their natural advantages. The natural resource-based activities can be converted into knowledge-based industries and lead growth for long periods of time (Thom and Soo, 2006). The role of the university by both research and promoting dialogues is key to reach this latter goal.

In recognizing the role of HEI in STI, it is important to stress the need by Tanzanian universities to understand the dramatic transitions that has taken place in university research throughout the past years, in more developed countries:

• Evolution of the role and value of knowledge
• Changes in the methods for the production of knowledge
• From individual research to partnerships-collaboration and to networking
• Articulation of the national S&T systems
• Internationalization of research

In general it can be resumed that changes have been produced in the definition of research programs, shifting from academic interest and those of the scientific community, and the determination of scientific priorities to those interests based on demand addressed to applications, and social and economic priorities. This change has been accompanied by changes in the way of research from mono-disciplinary or mono-thematic research to trans-disciplinary research, and also by changes in the organizational model, from individual or group to a more horizontal and international teams.

The channels of diffusion of results have also changed from the traditional academic channels to the management of results: transfer and commercialization. Funding is no longer centred in the public source and quality control is exercised not only by peers, scientific excellence and ex-ante examination but by peers and others, quality, pertinence, transferability, ex-post analysis and social value.

Under such context the new forms of the production of knowledge are trans-disciplinary, heterogeneous and conducted by teams, multiple actors, characterized by cooperation and networks, context of application, social profitability of knowledge and evaluation criteria based on quality, pertinence and transferability. Tanzanian HEI and the STI system as a whole must understand that today research is not an expontaneous and individual activity and requires the articulation of an interactive system which is integrated by factors, normative, organizational and functional elements.

There is a large set of both external and internal forces that shape and influence the Tanzanian STI system and the higher education system, as conceptualized above. These will be resumed in the next section.

Chapter 2

The Social and Economic Context and Future Prospects

2.1. Social – Economic Situation: A brief overview

2.1.1. Social Sector

Tanzania is a country of 947,300 sq km (31st in size in the world) (885,800 land and 61,500 sq km water). By 2010 (est.) its population was 41,048,532. Population growth is estimated at present at 2.04%. The country has a "young", population, the median age being 18.3 years.

During the implementation of Mkukuta I (2006 – 2010) an important set of achievements were reached in the social sector, while severe challenges still remain, in particular poverty conditions have not greatly improved (near 30% of its population is below the poverty line) in general, Tanzania is unlikely to meet all of the Millennium Development Goals (MDGs) by 2015 (MPEE, 2006).

Investments in education (which will be dealt with further in this Review) and health in the recent past have enabled Tanzania to record improvement in the Human Development Index (HDI) ranking, from position 163 in the pre-MKUKUTA period to 151 in 2009, thereby moving from low human development group of countries to mid human development group of countries. The most formidable challenge now rests with further extension of the reach and improvement in quality.

Life expectancy has increased to 55 years (54 years for male and 56 years for females), mainly due to declines in HIV and AIDS prevalence and child mortality. The neonatal mortality rate has improved only marginally partly due to little improvements in maternal health. There are many factors contributing to poor maternal health and the challenge is to reduce the wide disparities across regions, and between rural and urban areas, education groups, and wealth groups.

Improvement in infant and under-five mortality rate has been largely due to gains in malaria control through improved diagnosis and treatment of malaria, as well as prevention through increased use of insecticide treated nets. In addition, success of other preventive measures, such as measles vaccination, vitamin A supplementation, and implementation of Integrated Management of Childhood Illnesses (IMCI) have enhanced child survival. However, disparities persist, between and within regions and districts, urban and rural areas, and by wealth status.

Other challenges include dealing with malnutrition, which accounts for more than 50 percent of child mortality. Four out of every 10 children under five years of age are stunted and about one out of every five is underweight. For children under the age of two years, evidence suggests that food security per se is not the most critical determinant of the high prevalence of under-nutrition, but rather breastfeeding practices. Child malnutrition fuels illnesses, undermines learning, erodes human capital and reduces labour productivity, ultimately affecting growth and labour market outcomes at the adult age.

Malaria, TB, and HIV and AIDS affect Tanzanians in the health and economic dimensions. There have been important and successful interventions in some of them, as deceases such as TB and leprosy has seen progress in control and HIV / AIDS has seen a decline. In spite of progress there are serious weaknesses in service delivery, particularly in rural areas.

Although medical schools and enrolment have increased over the years, there is still a shortage of health professionals, especially the more skilled cadres. The shortage of skilled health professionals, which is most felt in rural areas, is estimated to be 65 percent. Moreover, existing health professionals are unevenly distributed, with significant disparities within regions and within districts.

Tanzania recognizes youth unemployment as the most serious employment challenge facing the Nation. Among all age categories, the youth have the highest rate of unemployment, especially in urban areas. The labour force is estimated (2009) at 21.23 million, agriculture: 80%, Industry and services occupy 20% of the labour force. The size of the informal sector is substantial

2.1.2. Economic Sector

In the past years, Tanzania has implemented a number of economic oriented core policies and structural reforms including; Trade and Exchange Rate Liberalization, Public Service Reforms, Investment Promotion, Tax Reforms, Financial Sector Reforms, Legal Sector and Local Governance Reforms, the National Anti-corruption Strategy, and others. These have improved confidence on the economy, and one consequence is the improvement in the flow of ODA and FDIs.

Tanzania is among the largest recipient of foreign aid. External resource flows have increased from about $ 1.1 billion in 2000 to about $ 2.8 billion in 2008, mainly provided in the form of direct budget support, moving away from project support. The budget support mechanism has improved predictability of external resource inflows and therefore improved budget planning and execution. Tanzania is one of the ten pilot countries to be benefitted from the Gleneagles Scenarios in the coming years.

The value of Foreign Direct Investment (FDI) has been increasing since 2005, averaging to USD 603.3 million annually. The largest share of FDI inflows went to mining and tourism. The mining sector, despite the benefit of large FDI inflows, is yet to substantially trigger domestic processing and make use of local supply chains. FDI has also been affected by the low level of human resource development in terms of quality and skills, which limit the exploitation of advantages associated with FDI. Indeed, improvements in the business environment can unleash the investment potentials in all sectors, including agriculture.

As a consequence of the reforms, and favourable external conditions, the economy has recorded a high GDP growth (6% in 2009, compared to 7.4% in 2008 and 7.1% in 2007). At present the estimated (2009) GDP stands at US $57.69 billion, as compared to US $ 54.43 billion in 2008 and US $ 50.66 billion in 2007. The GDP per capita (PPP) is estimated (2009) at US $ 1,400, compared to US $ 1,300 in 2007. Continued donor assistance and solid macroeconomic policies supported a positive growth rate, despite the world recession. In spite of increasing efforts however, Tanzania is in the bottom 10% of the world's economies in terms of per capita income.

The external debt stock has declined from US$ 7,384 million (106.9 per cent of GDP) in 1997 to US$ 5,846 million (34.6 per cent of GDP) by 2007. By and large, the majority of the external debt stock comprised of multilateral debt, although bilateral, commercial and export credit continue to be important sources of external resources. The drop in the external debt stock is mainly a reflection of the benefits of the debt relief under the Highly Indebted Poor Countries HIPC initiative. In 2009 the inflation rate has been estimated at 12.1% as compared to 10.3% in 2008.

Exports amounted to around 3 billion US $ in 2009 placing the country in 122th position worldwide, down from US $ 3.4 billion in 2008. Imports amounted to 5.8 billion US $ (2009) down from 6.4 billion in 2008.The main exports were: gold, coffee, cashew nuts, and cotton. The main imports have been consumer goods, machinery and transportation equipment, industrial raw materials, crude oil. In 2009 the main export partners were: India 8.51%, China 7.55%, Japan 7.12%, Netherlands 6.21%, UAE 5.71%, Germany 5.17%, while the main import partners were: India 13.97%, China 13.71%, South Africa 7.8%, Kenya 6.89%, UAE 4.65%, Japan 4.34%.

Since 2005, the exchange rate has been fluctuating, with negative effects on the import bill, official reserves, and macroeconomic stability. Moreover, the import bill has been expanding faster than export earnings, thereby causing increases in the trade deficit. Since 2005, the proportion of exports as a percentage of GDP has ranged between 21.7 percent and 23.1 percent, mainly sustained by increases in exports of non-traditional commodities – largely minerals and a modest increase in the export of manufactured goods.

The key contributor to growth has been the agricultural sector, although labour and crop productivity remains low. In 2009 it is estimated that this sector represented 26.4% of GDP. The Agriculture growth averaged about 4 percent between 2005 and 2008. The sector's sluggish growth is a result of poor infrastructure to support agriculture, inadequate extension services, poor production technology, low value addition, lack of appropriate financing mechanism for agriculture, absence of reliable market and prices and environmental degradation. Arable land represents 4.23% of the territory, while permanent crops occupy 1.16%. The agricultural sector provides 85% of exports, and employs 80% of the work force. Industry traditionally featured the processing of agricultural products and light consumer goods.

The fisheries sector has maintained a modest growth since 2000, attaining a rate of 5.0 percent in 2008, which was estimated to fall to 3.0 percent in 2009. Tanzania has immense fishery resource potentials, the main challenges include illegal fishing and trafficking of fish and fisheries products across borders, which reduce the sector's contribution to growth and reduction of poverty and undermine its sustainable development. Specific constraints for small and medium scale fishing include credit facilitation and resource degradation.

The industrial manufacturing sector contributed around 22.6% to GDP and its production growth rate has been estimated at 6.7 % (2009). The main products come from agricultural processing (sugar, beer, cigarettes, sisal twine); diamond, gold, and iron mining, salt, soda ash; cement, oil refining, shoes, apparel, wood products, fertilizer. Between 2005 and 2008, it grew at about 9 percent annually, with the highest growth being 9.9 percent in 2008. Despite this relatively good performance, the sector is constrained by high costs of doing business, mainly due to unreliable supply of utilities (water, power, etc), leading to capacity underutilization; ineffective transport networks and other ICT&STI infrastructure; and small domestic markets, with intense import competition, and inadequate export drive.

Tanzania has deposits of gold, diamond, tanzanite, ruby, tin, copper, nickel, iron, phosphate, gypsum, coal, natural gas and potential for petroleum extraction. Mining involves large and small scales, both of which are important. Before 2007, the sector grew at about 15 percent annually, which dropped to 2.5 percent in 2008 due to the ceasing of export of diamonds and decreased gold production. Such wide fluctuations in growth are one of the challenges facing the sector. Other challenges include weak linkages between the sector and local supply chains, hence low domestic value addition; limited multiplier effects and employment creation; environmental-related conflicts; and technical and institutional capacities for effective management of the sector. Because of its high potentials, the sector has been identified as a driver of growth.

There have been modest improvements in growth-related infrastructure such as roads, ports (sea and air), energy, etc. However some challenges still need to be addressed, including frequent power shortages, port congestion, and poor conditions of rural roads. Tanzania could act as a regional trade and logistic hub if it were to exploit its advantageous geographical location and immense potential for power generation.

In general though reforms are being implemented, the business environment in Tanzania remains poor, recent banking reforms have helped increase private-sector growth and investment and privatization efforts have been partially successful. Small and medium enterprises contribute significantly to the economy, but face numerous constraints such as infrastructure. The financial sector has undergone deep reforms, but access to finance remains low and the banking sector remains relatively unscathed amid the global financial crisis.

2.1.3. Services sector

Available indicators show that progress in the water sector has been slow which is explained by a history of under-investment in water infrastructure. Between 2000/01 and 2007, households' access to clean and safe water sources, in both urban and rural areas, declined from 90 percent to 79 percent and from 46 percent to 40 percent, respectively, particularly because investment in water supply infrastructure did not keep pace with population increase. Also, existing water points have not been sustained - over a third of the rural water points are not functioning any more two years after installation. The water sector reforms such as decentralization and the introduction of an independent regulator in urban areas provides opportunities for increasing participation and accountability. .

On the other hand, hygiene practices are constrained by lack of basic latrine, together with shortages of water and soap, unsanitary latrines and poor waste disposal. Urban centres are experiencing high population increase, which is outstripping increase in the provision of services. Hence, most urban settlements are increasingly developed outside the formal planning and management system. Peri-urban areas are increasingly being sub-divided into smaller plots by land owners and development takes place without paying regard to plans for provision of basic community facilities and services. Unplanned settlements have increased as to include developments on hazard-prone lands such as steep slopes, flood plains, river valleys, and dumpsites. Also, Commercial Business Districts (CBDs) of most urban centres are increasingly becoming congested.

The challenges facing settlement planning and management in Tanzania include inadequately serviced land for shelter and human settlements, especially for women, youth, the elderly, disabled and disadvantaged. Other challenges include poor infrastructure and

poor social services, inability to create employment opportunities, low capacity for training professionals for land use planning and technical, financial and managerial responsibilities.

Tanzania has some of the world's finest tourist attractions and game reserves, which qualifies it as a growth sector, with immense opportunities for expansion. Tourism is an important contributor to services and is given a top priority in its development, it represents 50.9% of GDP (2009 est.).

Among services, a general assessment of telecommunications shows that these remain inadequate; system are operating below capacity and being modernized for better service; small aperture terminal (VSAT) system under construction. In the domestic front, fixed-line telephone network is inadequate with less than 1 connection per 100 persons (179,849 in 2009, placing it at the 126th place worldwide); mobile-cellular service, aided by multiple providers, is increasing rapidly (14.723 million in 2009, placing it in the 46th place worldwide); trunk service provided by open-wire, microwave radio relay, troposphere scatter, and fibre-optic cable; some links being made digital.

The country is served by satellite earth stations - 2 Intelsat (1 Indian Ocean, 1 Atlantic Ocean). The number of internet hosts, 24,724 (2009) places the country in 96th position worldwide, while the number of internet users, 520,000 (2008) places it on106[th] place.

In the energy sector, the country produced over 3.4 billion kWh (2007 est.) and consumed 3.2 billion kWh (2007 est.). There is no oil production and the country consumes 34,000 bbl/day (2009 est.). The natural gas production is estimated at 560.7 million cu m (2008 est.) and the consumption at 560.7 million cu m (2008 est.), the proved gas reserves is estimated at 6.513 billion cu m (1 January 2009 est.).

2.1.4. Environment and Natural Resources

The country is rich and diverse in natural resources and faces important environmental challenges caused by soil degradation; deforestation; desertification; destruction of coral reefs threatens marine habitats; recent droughts affected marginal agriculture; wildlife threatened by illegal hunting and trade, especially for ivory. Clean water is at a premium and overgrazing has contributed to soil degradation and desertification. Biodiversity is threatened by overfishing and illegal hunting. It is estimated that the impact of climate change is likely to be significant. In general, the government is taking steps to improve environmental oversight, but significant positive outcomes are yet to be seen

Tanzania is party to several international agreements on the environment (Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, and Hazardous Wastes, Law of the Sea, Ozone Layer Protection, and the Wetlands).

Sound economic governance of natural resources is critical for poverty reduction, not only for the communities in the locality, but also for the whole nation. Despite their abundance, natural resources have had limited impact on the livelihoods of the poor and the economy in general due to weak management. The economic value of revenues received from concessions and licenses from mining, forestry, fishing and wildlife commodities is low. Tanzania's recent joining in the Extractive Industries Transparency Initiative (EITI), is timely, since it will avail opportunities to enhance governance in natural resources.

2.2. Vision 2025: The Development Perspective

Between 1995 and 1999, the Tanzanian Government prepared a "Development Vision 2025" (Planning Commission, 1999) understood as "an articulation of a desirable future condition or situation which a nation envisages to attain and the plausible course of action to be taken for its achievement" The Vision brings out the feeling and desires of the Tanzanian society, several of which can have a response from the STI system and in particular HEI as part of it.

Mallya (N/D) is critical of the Development Vision as in his view the Vision puts a set of over ambitious goals and objectives which are too many for a poor, dependent economy to pursue concurrently in as a short a period of 25 years. In particular it is pointed out that there is a set of internal weaknesses and problems that need to be addresses as a prelude to the search for the objectives of Vision 2025.

The Vision was conceptually built on the belief that by the mid-1980's past development policies and strategies, although successful for setting the basis for national unity, social cohesion, peace and stability, were not adequately responding to changing market and technological conditions in the regional and world economy and were also not adapting to changes in the domestic socio-economic conditions.

The Vision sets its goal to see that Tanzanians will have graduated from a least developed country to a middle income country by the year 2025 with a high level of human development. The economy will have been transformed from a low productivity agricultural economy to a semi-industrialized one led by modernized and highly productive agricultural activities which are effectively integrated and buttressed by supportive industrial and service activities in the rural and urban areas. A solid foundation for a competitive and dynamic economy with high productivity will have been laid. Consistent with this vision, Tanzania of 2025 should be a nation imbued with five main attributes.

a) *High quality livelihood*. The creation of wealth and its distribution in society must be equitable and free from inequalities and all forms of social and political relations which inhibit empowerment and effective democratic and popular participation of social groups in society. By the year 2025, racial and gender imbalances will have been redressed such that economic activities will not be identifiable by gender or race. All social relations and processes which manifest and breed inequality, in all aspects of the society (i.e., law, politics, employment, education, culture), will have been reformed.

b) *Peace, stability and unity*. A nation should enjoy peace, political stability, national unity and social cohesion in an environment of democracy and political and social tolerance. Although Tanzania has enjoyed national unity, peace and stability for a long time, these attributes must continue to be cultivated, nurtured and sustained as important pillars for the realization of the Vision.

c) *Good governance*, By 2025, good governance should have permeated the national socio-economic structure thereby ensuring a culture of accountability, rewarding good performance and effectively curbing corruption and other vices in society.

d) *A competitive economy capable of producing sustainable growth and shared benefits.* Tanzania should have created a strong, diversified, resilient and competitive economy which can effectively cope with the challenges of development and which can also easily and confidently adapt to the changing market and technological conditions in the regional and global economy

e) ***A well educated and learning society***. Tanzania envisages becoming a nation whose people are ingrained with a developmental mindset and competitive spirit. These attributes are driven by education and knowledge and are critical in enabling the nation to effectively utilize knowledge in mobilizing domestic resources for assuring the provision of people's basic needs and for attaining competitiveness in the regional and global economy. Tanzania would brace itself to attain creativity, innovativeness and a high level of quality education in order to respond to development challenges and effectively compete regionally and internationally, aware of the reality that competitive leadership in the 21st century will hinge on the level and quality of education and knowledge.

2.3. Kilimo Kwanza: A framework for agricultural development

Agriculture is the backbone of the economy, 80% of the country's population depends on it. Thus the country has directed many efforts to the sector, but in spite of them, it has not performed well, the volume of production has decreased while the population doubled. In the more recent years, an increase in the budget allocated to agriculture increasing from 2.9% in 2001/2002 to 6.6% in 2008/2009, a positive trend has begun to emerge and government has considered that this trend should be put into a structured frame. Such framework is "Kilimo Kwanza", meaning that the totality of the national development effort should be directed – on priority basis, to the implementation of Tanzania's green revolution, as an ultimate vehicle for the social and economic transformation that the country requires.

There are several reasons why such strategy is necessary, principally the fact that agriculture will continue to be for some time the backbone of the economy, food security is crucial, poverty reduction is a national objective, reverse or at t least attenuate rural – urban migration, use agriculture multiplier effects, contribute to health problems stemming from malnutrition. Considering that there are favourable conditions to impulse agriculture, the strategy calls for a paradigm shift based on a new production pattern that considers cash crops, horticultural crops, livestock industry, meat industry, dairy sector, fisheries and others. Within this framework, human resources are certainly key for the transformation to take place.

2.4. MKUKUTA II: The National Strategy for Growth and Reduction of Poverty

Mkukuta II (MFEA, 2010) is an organizing framework set to define the efforts that are necessary to accelerate the reduction of poverty. The Tanzanian Government has placed a high priority in the implementation of this Strategy to take place for five years (2010/11 – 2014/15). MKUKUTA II is informed by the aspirations of Vision 2025. Government is in the process of preparing the Long Term Growth and Development Plan, which will represent its development framework for the remaining 15 years of Vision 2025. MKUKUTA II therefore implements the first 5-years of the Long Term Growth and Development Plan.

The Strategy is built on four key fundamentals, which have elements that pertain directly to the performance of HEI in the STI system, to ensure forward looking interventions to achieve the targets set out in the Vision 2025 and other long term policy initiatives:

- Efficient use and development of factors of production, including human capital/resources
- Strengthening and establishing well functioning institutions and markets

- Provision of infrastructure
- Ensuring good economic governance

The Strategy sets a large number of ambitious goals to be reached by 2015 and recognizes the responsibilities of public and private sector organizations in order to achieve them. Of relevance to this Review, is the recognition by Government and stakeholders alike that strengthening of capacity at various levels (leadership, policy analysis/formulation, strategic planning, implementation, coordination, supervision and monitoring) ought to be priority. The Government considers crucial to build the human resource base and to improve technical capacities of organizations and institutions to improve service delivery.

The Strategy recognizes that human resources remains one of the critical constraints in its effective implementation and the execution of sector policies, strategies, programs and projects. In order to address issues of human resource and capacity, the Government and other stakeholders are to focus on a national agenda for building a capable state. The agenda includes a set of actions which will serve also to strengthen the STI system and HEI.

The Strategy also recognizes the need to transit to a knowledge-driven economy, and as such recognizes that research is important and urgently requires special attention, particularly those activities that contribute to drivers of growth and drivers of poverty reduction. Investment in R&D should be driven by a need to address a given practical problem of technological, commercial, economic, social, as well as environmental application. To develop a strong national system of innovation, the links and integration between research, policy and productivity, particularly in manufacturing, agriculture and trade logistics sectors are recognized as critical.

Directly related to HEI in the STI system are the goals destined to ensure equitable access to quality education and to ensure the expansion of higher, technical and vocational education to support growth. These latter goals aim at preparing skilled and competent professionals in various trades. The Strategy aims at generating the required number and skills for the growth drivers in agriculture, manufacturing, tourism, mining, services and trade logistics.

2.5. The External Context and Future Trends

To understand and explore the future development of STI and in particular determine the performance of HEI, it is necessary to explore the present and future global and regional developments and trends that provide opportunities and pose threats to the national STI system. This Review has not conducted a formal trend analysis, but it is important to recognize at least some of the more important.

In the past years the development process has become more complex and challenging for a number of reasons, certainly globalization and the fast pace of technological advances are two key reasons, although the internal social and cultural dynamics of the countries, each with its very particular characteristics contributes greatly to an immensely diversified picture of the world. Both phenomena, leading to a knowledge-based economy, play a key role in shaping Tanzania's higher education strategies.

The higher education levels at world level will continue to generate more social and economic prosperity, and modern and competitive economies will need more educated workforce. Such trend demands that this level rises in Tanzania, as its impacts the STI system in several ways: a) better education will produce more informed citizens, who will be

demanding more products and services, while at the same time become more aware of environmental, health, social and other issues; b) such trend will also require further level of sophistication in the development and access to new technologies and their benefits such as the development of new ways of social relationships.

The observed world and regional economic trends show a continuous progress in market globalization, in spite of growing opposition. Existing trends impose the need for changes in STI policies to allow the country compete in global and regional markets. Within the mechanisms being foreseen to exert higher control over the global economy, it is possible that the opportunity arise that technology and innovation will be easier to reach by developing countries such as Tanzania, imposing the need to change STI policies to facilitate FDI, considering nonetheless that developed countries will still retain innovative processes and decision making.

Four recent global developments have urged states to reposition themselves to benefit from globalization, with education playing a key role in that regard. These developments are: a) The Dakar Declaration on Education for All, 2000; b) The United Nations Millennium Development Goals, 2000; c) The Commission on Social Dimensions of Globalization, 2004; d) The Blair Commission for Africa

Other important economic trends show the diminishing weight of the OECD countries in the global economy in favour of newly industrialized or more advanced developing countries, such as China, Brazil, India. One important influence of this trend in Tanzania has to do with the growing presence of these latter countries in its FDI, not to mention the presence of South Africa as the regional powerbroker. The growth of non-OECD countries is pressing for a higher demand of energy resources and raw materials, implying the need to carefully plan and define strategies for their exploitation, in particular in view of the also growing presence of global companies.

One trend that is becoming important is the so called endogenous development policies, emphasizing the use of natural resources, local infrastructure and human capacities that are available at the national level. Tanzania is placing an important priority in the development of such capacities and in particular the recuperation and use of more traditional technologies, for further increasing productivity in both the industrial and agricultural sectors.

Considering other trends and their impacts over research and innovation, population growth should impose more research dedicated to improve food production and develop initiatives oriented to mitigate environmental impacts. At the same time the growth of urban areas must trigger more research on urban related problems and define initiatives to increase productivity in rural areas.

As important as the educational trends are those related to the environment, which poses important challenges to the STI system, by for example research and understanding of climate change, including the developmental use of innovative tools to reduce negative impacts. The diminishing bio-diversity trend also has an important impact on the renewed definition of environmental policies and the need of increasing research funds particularly addressed in understanding complexity. Other environmental trends that will have impact have to do with the increase of natural hazards and critical levels of water. All the above impose the development of policies and national programs to respond to climate change, having the essential component of research and innovation.

Technological trends will certainly impact the Tanzanian STI system and HEI in STI, among them the development of new energy sources, the use of nuclear energy, the continuous medical progress, in particular relation to HIV/AIDS, and the development of transforming technologies, such as nanotechnology and technology convergence (nano-bio-info-cogno). Such trend imposes a fresh and new look at the traditional STI and R&D policies.

Specially related to the technological trends are those of the growing presence of international strategic alliances in R&D. These will certainly increase in the future as firms will engage in partnerships in order to access foreign technologies and markets, as well as to minimize risks. Tanzania has to benefit from these partnerships provided it can build a strong local STI base and carefully define partnership strategies. The transfer of technological knowledge directly or through the above form of associations will produce a definite and dramatic impact on the national economy. Moreover such phenomena will have a direct impact on the demand for highly qualified graduates and a flexible labour market that will facilitate the adaptation to new technologies.

Key in the process of performance of HEI in STI is the vision of internationalization, which is a characteristic of today's R&D efforts globally and one definite way Tanzania HEI can actively participate in STI. In fact, the world has witnessed impressive changes in co-publication, in 1976 Co-publications represented 9.7% of the total number of scientific publications in Germany while in 2005 they represented 47%; similar changes are observed in Spain, from 9.5% (1976) to 42% (2005); in France 10.3% (1976) to 49% (2005); United Kingdom 10% (1976) to 44% (2005). Similar figures can be found in Latin America. Internationalization should permit to advance more rapidly in the development agenda

The above will demand the creation of a supportive environment for STI and HEI that is today still very weak in the country. The world trend shows that countries are striving to create new fiscal initiatives, reinforce IPR legislation, and raise human resources qualifications, coordinating efforts among ministries and other state and regional institutions, in general producing changes and improvements in governance structures.

The world trend in modernizing higher education institutions is particularly relevant in this Review. As already discussed, the growing knowledge economy implies an increasing need for highly skilled workers and HEI are called upon to provide such a workforce. Today, educational methods are changing so as to reinforce student's capacities for analysis, debate and questioning. This trend has several implications for Tanzania, among them the need to upgrade university curricula, incorporate new technologies in programs, modify teaching methods, permit higher mobility of students and academic staff, sending students abroad under government or private sponsorship.

The forms of definition of policies and strategies at the world level is also changing, today it can be seen more integrated innovation systems approaches, the growing use of foresight techniques, the introduction of alert systems, the increasing importance of technology assessment and other elements of policy that are key for building up a solid STI and HEI base in any country. Tanzania has the opportunity to participate in the transformations taking place by accessing knowledge and expertise through the existing multilateral and bilateral cooperation efforts.

Chapter 3

The Tanzanian Science, Technology and Innovation System: An Overview

Tanzania has for several decades dedicated many efforts towards the build-up of science and technology, and more lately of innovation capacities. It is not the purpose of this Report to make an in-depth analysis of the system, which has already been done by several authors and will be done again by an OECD review in 2011, but rather describe its general features in particular those which have to do with HEI in light of the STI system already discussed in Chapter 1.

3.1. Governance of STI

3.1.1. Institutions

a) The Ministry of Communication, Science and Technology (MCST)

The Ministry of Communication, Science and Technology (www.mst.go.tz) is the head of the Science and Technology system as a policy making body, it is mandated to coordinate R&D activities. Other ministries are also in-charge to oversee R&D activities in their respective sector. The Ministry was created after an institutional reform that abolished the Ministry of Science, Technology and Higher Education. In the latter case, the Ministry placed a much larger emphasis on higher education and at present it is placing it on communication.

b) The Commission for Science and Technology (COSTECH)

COSTECH is a parastatal organization, established in 1986, now under the Ministry of Communication, Science and Technology. Its main objectives are to coordinate and promote S&T development activities. It is also the main advisor to Government. The Commission has established standing committees (Research and Development Advisory Committees) which act as the organization's think tanks on different issues. At present there are Committees in: agriculture and livestock; natural resources; industry and energy; public health and medical research; environmental research; basic sciences; social sciences; development and transfer of technology; and biotechnology.

In addition COSTECH serves three other national technical committees: Tanzania Award for Scientific and Technological Achievements (TASTA); National Award for Research in Science and Technology (NARST) and National Award for Environmental Management (NAEM)

Under COSTECH operate the National Research Registration Committee and the National Fund for the Advancement of Science and Technology. Internally it operates through the Directorate of Research, Co-ordination and Promotion, the Directorate of Information and Documentation, the Directorate of Administration and Finance and the Centre for Development and Transfer of Technology.

The Research Registration responds to the requirements that foreign researchers seek special clearances to conduct research in Tanzania's mainland. COSTECH is entrusted with the responsibility of screening such foreign researchers. The Government of Zanzibar grants

its own permits. National researchers not affiliated with institutions are required to apply for clearance. This system is considered a first stage towards the registry of research in the National Research registry. It is to be noted that COSTECH may suggest alternative research within the applicant's interest.

The National Fund for Advancement of Science and Technology was established under COSTECH in 1995, as an inter-ministerial fund channelled by the Treasury through the MCST to provide resources for a large set of scientific and technological activities, R&D, technology development, award prices, support meetings, school science fairs, scientific expeditions, publications, writing of textbooks, assist in the acquisition of scientific equipment, support scientific and engineering societies and provide fellowships for training and enable participation in meetings

By 2004 only 44 projects for an amount of TAS 195 million had been supported and an application of 11.5 billion had been unfunded. The recent (2009) establishment of a new fund of 30 billion has boosted research funding to a great extent. Further, government has committed itself to apply 1% of GDP to R&D as of 2009/2010. This goal will not be reached so soon.

c) The Tanzanian Academy of Sciences

The Academy is a learned non-governmental organization established in February 2004 and registered in 13 April 2005 with the main objectives of "promoting S&T learning and the utilization of S&T knowledge for national socio-economic development, as well as to provide a forum for the discussion of various issues pertaining to science and technology". The Academy is made up of 25 founding members, and has conducted a limited number of activities. Because of its membership it has a potential to contribute to the operation of the STI system, if the appropriate internal and external means can be found. The vision of the Academy is to be a leading world class scientific organization on the advancement and application of S&T knowledge and, pursuant to this vision, it has established a working strategy, which has yet to be implemented.

3.1.2. Policies

Tanzania has recently defined (or is in the process of defining) a set of policies and strategies for the build-up of STI capacities. The most important of these are:

a) The National Research and Development Policy (June 2010)

The policy recognizes that research plays a crucial role in social and economic development, and that Tanzania has been undertaking significant research efforts in few areas, but results have not been translated into tangible products, processes and services for development purposes. The policy has been adopted to substitute that of 1996 which was based on a linear model (supply sided) of research, with little emphasis on innovation and the role of market forces. The policy at the same time is embedded in the present social and economic policies and the National Development Vision 2025, with the final aim to develop a competitive knowledge economy, which is skill-based, knowledge and innovation driven, and thus capable of generating and sustaining dynamic development.

A large number of factors that hinder the utilization of research results are recognized by this policy document, in particular the weak multi-disciplinary interaction and collaboration between R&D organizations, weak social and economic research, inadequate mechanisms

for including new and emerging research areas into the national research agenda and low participation of the private sector in research activities. These limitations are exacerbated by inadequate human resources, over dependence on foreign funding and inadequate appreciation of the role of research in national development.

Under such context, the Policy is destined to strengthen the research capacity so as to bring about increased competitiveness and provides guidelines on how research should be conducted in all sector of the economy in order to:

- Establish an appropriate coordination and management system of research activities
- Set clear and realistic priorities for research on short, medium and long-term basis.
- Rationalize the use of the country's natural resources through R&D activities.
- Increase Government's budgetary allocation to research and set guidelines for increasing the share of the private sector in funding R&D.

b) The Ministry of Communication, Science and Technology Master Plan

The Master Plan (MP) 2010-2020 (MCST, 2010) recognizes the country's weaknesses and limitations in STI and aims at setting out a long-term plan that will guide the implementation of the mandate of the Ministry of Communications, Science and Technology (MCST) in the next decade. The main aims of the Plan are:

a) To realign MCST with the current and future national priorities, immediate society needs, ongoing public sector reforms, and stakeholders and market demands, and

b) To accelerate the development of STI and harness its full potential and that of ICT to improve education and innovation, public sector management, private sector competitiveness in key strategic productive areas, industrialization, capacity building, and poverty reduction in line with key sustainable development objectives as set in MKUKUTA, TDV 2025, the MDG, as well as other national development policies and strategies.

The preparation of the MP involved a large set of stakeholders in the public, academic, private sector and civil society organizations.

The Plan defines the MCST long term goal in the next decade as a catalyst that will enable the country to raise its productivity and competitiveness, and to improve the standard of living and quality of life of Tanzanians through promotion and effective use of S&T, information, and innovation processes, products and services in both productive and non-productive strategic sectors of the economy.

It defines that STI will be used in strategic areas of the economy to enable the acceleration of real GDP growth from the current 5% to 9 % by 2020. MCST areas of strategic focus in 2010-2020 will be: food security; high-value highly demanded processed agricultural and natural resources products and services; education and STI capacity and capabilities development; water; energy; infrastructure-technical and informational; and health.

Besides these seven strategic areas the Plan also defines other priorities to be pursued: indigenous knowledge and technologies; environment management; industrial development; ICT; social sciences; basic research in the fields of agro-biotechnology, medicinal

biotechnology, profitable and high-utility emerging STI and its applications, e.g. nanotechnology; R&D in trade.

c) *The National Science, Technology and Innovation Policy (draft of April 2008) to revamp the Policy adopted in 1996*

In April 1996 the Government, through the then Ministry of Science, Technology and Higher Education (MoSTHE), published a revised National Science and Technology Policy (MCST, 2008) which is recognized to have produced a limited number of policy, institutional and research achievements, but that in general the lack of implementation associated with improper funding, resulted in a negligible S&T impact on the national economy.

The driving force and preconditions behind the formulation of the 1996 Policy was overtaken by many social and economic events and it did not address some critical issues related to the rapid technological change that had taken place at the end of the 90's and beginning of the 2000's.

One important shortfall in the 1996 S&T policy was the conception and subsequent practice of an S&T that seemed to be an end in itself, without the important compliment of innovation. Another limitation of the 1996 S&T policy has been the almost continuous lack of a consideration of innovative and entrepreneurial skills and spirit connected with S&T ventures, particularly in formal educational settings and S&T training programs in post-secondary training centres and institutions of higher education and training.

Further, it is recognized that the 1996 policy stipulated the need for, and pledged development of a list of S&T indicators that were to reflect the stage of national development, the resource base as well as the special features of the S&T system, to date, little has yet been achieved in this area.

Under such context the MCST initiated the formulation of a new Plan which would guide the country into creating renewed capacities in STI. The Plan (not yet adopted) contemplates a large set of priorities organized under focal areas, each within a main policy issue, contemplating specific objectives and strategies:

- *National STI Agenda*, providing STI the highest possible national prominence; mainstreaming STI into all sectors of the national economy; promoting a scientific culture across the board; creating a mechanism for setting up and periodically reviewing the national STI agenda and creating participatory mechanisms for reconnaissance, fore-sighting, planning, implementation, monitoring and evaluation system in STI related issues.

- *Institutional, Legal and Regulatory Framework*, strengthening the STI institutional, legal and regulatory framework; enhancing efficient and effective planning, implementation, coordination, monitoring, evaluation and accountability of R&D institutions and strengthening linkages among R&D institutions, COSTECH, public institutions and the private sector.

- *Education and Training*, ensuring equitable access and expansion in enrolment of students in science subjects at all levels; facilitating the availability of well-trained teaching staff and laboratory and other technicians; providing access to high quality laboratory, equipment and supplies; ensuring quality and relevant curriculum coupled with scientific approach in teaching; stimulating science and technology interest

among children and youth; establishing centres of excellence to address core STI concerns; ensuring sustainable STI human resources in line with the economic growth trends; nurturing excellent brains for critical STI priority areas and strengthening special science secondary schools.

- *Level and Mechanism of STI Funding*, guaranteeing adequate funding for STI; and ensuring effective utilization of STI funds.

- *Innovation, Transfer and Diffusion of Technology*, fostering partnerships and linkages amongst R&D institutions, industry and government for effective innovation, transfer, indigenization and/or commercialization of technologies that will enhance spin-off firms; providing support mechanism such as IPR, technology incubators, cluster initiatives and licensing systems for effective technology innovations, development, transfer, indigenization and/or commercialization; facilitating assessment of technology needs in the country, acquisition, partnerships and technology adaptation and diffusion in the country.

- *Indigenous Knowledge Systems*, promoting consciousness and commitment to documentation, preservation and transmission of Tanzania's indigenous knowledge and technologies for the benefit of society; facilitating value addition to indigenous knowledge, resources and technologies for the purpose of socio-economic benefits; protecting scientific discoveries and technological innovations arising from indigenous knowledge and resources.

- *New and Emerging Technologies*, ensuring that new and emerging technologies are mainstreamed into STI system including education and training at all levels; enhancing physical infrastructure and human resources capacity for effective utilization of new and emerging technologies to enhance socio-economic development; ensuring that utilization of new and emerging technologies adheres to principles and requirements of safety, ethics and environmental sustainability.

- *Strategic Collaboration and Partnerships*, strengthening collaboration at national, regional and international levels as well as with the Diaspora in strategic areas such as funding, capacity building, knowledge sharing, exchange of experts and technology transfer; building capacity to exploit opportunities pertaining to strategic collaboration.

- *Cross-cutting Issues*
    - *Equitable access to STI processes, products and services*; ensuring equitable access and redressing imbalances to STI processes, products and services to all population segments.
    - *Environmental Sustainability*, establishing the extent of environmental degradation from STI-related activities, building capacity to address and enforce environmental issues and laws, ensuring that STI-related activities do not lead environmental degradation.

d) COSTECH Strategic Plan 2009 – 2012

In its vision as a prime driver of STI for sustainable development, COSTECH has defined a Strategic Plan for the period 2009 – 2012. It is composed of a set of important objectives, outputs and outcomes, which follow the MCST Plan but provides a whole set of internal policies and strategies. Funding for the Plan is expected from the Government, SIDA and World Bank.

e) Sustainable Industries Development Policy 1996 – 2020

The Policy (MIT, 1996) set out by the Ministry of Industry states that the goals towards which the industrial sector pursue include human development and creation of employment opportunities; economic transformation for achieving sustained economic growth; external balance of payments; environmental sustainability and equitable development. The area of human development is seen in the Policy as being reached by the development of agro-allied industries and the promotion of small scale industries and informal sector activities organized in all industrial branches offering broad-base entrepreneurial development potential for employment and income generating opportunities.

The Policy sets out a first phase for consolidating existing capacities and a second phase (2000 – 2010) for the creation of new capacities, focusing on areas with clear potential for gaining competitive advantages through the process of learning and application of efficient technologies. In this phase it is envisaged that new opportunities will be opened by taking into account emerging technological innovations. A third phase 2010 – 2020 is envisaged as a fully fledged process of investments in basic capital goods industries.

In order to achieve the goals set forth in the Policy, a set of actions is defined which will promote an enabling environment where both the public and private sector can operate, it includes: the development of the market mechanism; selective protection within WTO agreements; trade regime; fiscal policies; monetary policies, investment promotion policies, including intellectual property; promotion of standards and quality assurance; and infrastructure

The Policy recognizes that one of the critical factors for sustained industrialization is the creativity and productivity of entrepreneurs, managers and workers, and that the present industrial sector is characterized by a relatively poor quality of the labour force, inadequate technical and managerial skills and a general lack of an entrepreneurial cadre exposed to advanced industrial culture. As a response it is set out that Government will develop the education system with due emphasis on technical training.

The Policy also recognizes that the domestic industry has inadequate research activities. The success of the sector is expected to be strongly based on scientific and techno logical research. Further it is also recognized the lack of linkages between the few local R&D institutions and the productive sector in the country, due on one hand to the fact that industrialists do not appreciate the role of R&D, and on the other hand R&D does not address the actual needs of the productive sector. The Policy thus calls for the development of master plans, rationalization and synchronization of R&D institutions, articulation of areas for collaboration between manufacturers and R&D networks, particularly regarding financing and management of R&D institutions.

The Policy does not mention HEI explicitly, but it is of course clear that its implementation will require a strong and decisive intervention of the universities if it is at all to succeed, particularly in what the Policy defines as support institutions, that include standards and quality assurance and certification, R&D and environmental management.

f) National Biotechnology Policy (June 2010)

The Policy (MCST, 2010) adopted by the MCST is destined to "ensure that Tanzania has the capacity and capability to capture the proven benefits arising from health, agriculture

industry and environmental applications of biotechnology while protecting and sustaining the safety of the community and the environment".

The Policy recognizes the challenges that its development represents and calls for the availability of human resources and funding. It also calls for the participation of the private sector in its development and the creation of a National Centre of Excellence for Biotechnology and Genetic Engineering which will create platforms to support the biotechnology industry. The Policy defines also the need to develop bio-safety regulations and guidelines.

The Policy contains a set of statements, which at the end call for the preparation of a strategic action plan for the implementation of the policy directives. An Advisory Committee is envisaged to review the regulatory frameworks. In general the Policy is just declarative of a large set of intentions by Government, with severe challenges ahead for its implementation, in particular due to the lack of human resources and funding.

g) The National Information and Communication Technology Policy (NICTP) (2006)

The policy adopted in 2006 is set to facilitate the bridge of the "digital divide" for Tanzania, thus transforming its economy into a knowledge-based economy, able to effectively compete in the global economy.

In general it is clear that in spite of the efforts made by the Government to enforce the policies it formulates, there remains a problem of coordination among various sectors. Often, the different ministries, when formulating their own sector policies, have either ignored or just glossed over the central policy issues that could constitute a common agenda. In this way, these "sector" ministries have found themselves either inadvertently in opposite directions against each other or giving preference for internal ministerial interests. The need for tighter and binding coordination of policy cannot be but over-emphasized.

3.2. Research and Innovation /²

Research and Development is carried out by some 80 organizations spread throughout the country. The organizations cover the key social and economic sectors, and each R&D organization receives policy guidance from the parent ministry. R&D is conducted largely in the public sector.

The political and economic reforms undertaken during the 1980s and 1990s affected the R&D system in three important ways:

- Liberalization of the political and economic system allowed various groups in society to explicitly articulate their interests and participate in development management.

/² Important parts of this Section have been drawn from the work of Prof. Burton LM Mwamila who has made in-depth analyses of the situation of science and technology for several years and has published his results in various papers and documents. Also, much information was gathered from Wangwe, S., B. Diyamett, and A. Komba (2009) To these it has been added some more recent information gathered during the Mission undertaken to Dar es Salaam between 20 and 24 September, 2010. The authors thank the many informants who have made these additions possible, in particular the support and comments of Prof. Hasa Mlawa, who accompanied the authors in the Mission

- The redefinition of the role of the state and the consequent decline of the public sector, coupled with growth in the private sector, changed the pattern and sources of funding for R&D. Funding to the predominantly public R&D system has been on the decline. This situation has affected both the level of R&D activities and their direction.

- A number of users of R&D products, especially those whose demand was derived from the domestic market under the import-substitution regime of the 1970s, were weakened by competition from imports under trade liberalization. To the extent that imports have replaced domestic production, the demand for import – substitution - based goods and services from the local R&D systems has decreased.

In spite of the achievements that can be observed in the implementation of the different policies adopted throughout the years, these have been more the exception than the rule. There have been many limitations in reaching adequate R&D results, as recognized by the MCST, due to limited S&T personnel, lack of comprehensive national R&D and S&T policies and strategies, as well as inadequate financial resource allocation. Part of the wider problem has been the little inter-linkage and networking. Also, the rather weak and inadequate coordination that could have otherwise been offered and stimulated by a central national body, the central coordinating role provided for in the legislation that established COSTECH has often encountered a rather defiant sense by autonomous institutions under their own legal status.

In general, part of the existing limitations is derived from the lack of a better defined structural and functional linkage, destined to harmonize and synchronize the functions and/or activities of the R&D/S&T institutions. The current structure of the Ministry of Communication, Science and Technology (MCST) itself needs a review so as to accommodate existing developments and challenges in view of the fast-changing science and technological needs in society and in the world.

One other key problem in the R&D system of Tanzania is related to the quality of the research that is undertaken. Low quality discourages policymakers and private sector from using local research outputs and prompts them to seek research findings from abroad. To ensure research effectiveness, performance monitoring and quality assurance system has to be in place. There exists neither institutional nor national mechanism for assessing research performance by stakeholders in the country.

Following its several declarations, Government has put in place the National Fund for Advancement of Science and Technology (NFAST). Nevertheless, inadequate funding has remained a major constraint to research and innovation as well as to education and training in STI. Constrained funding also explains the currently inadequately equipped R&D institutions, as well as outdated research facilities in tertiary institutions.

During the 2003/04, the overall budgetary allocation to science and technology was only 0.24 percent, translated to less than 0.2% of the GDP. This situation has not improved by 2010. The figure is far below even the average for developing countries and the recently industrialized economies, such as South Korea (which spends above 2.0% of GDP) and Argentina, Brazil, Chile, Cuba, India, Kuwait and Mexico and South Africa, which spend between 0.5 to 1.0% of their GDP only in R&D.

Whereas there has been political will and commitment at national level, there has not been a comprehensive management system to effectively plan, monitor and evaluate STI education, training and research and development activities in the country. Often, research and

development activities are conducted in isolation and/or independently of a prioritized order of national and societal needs, with the result that research results—and any anticipated innovations—are known only to a few individual researchers.

There have been a number of potentially useful grassroots-level innovations reported by R&D institutions that have not been supported towards translation into tangible products, processes and services. There is clearly a need to diversify methods and strategies of disseminating research information and results beyond just research reports and journal articles. There is a need as well for regularized nationally supported ways and forums to broadcast results for purposes of systematic follow-up and/or informed decision-making. Further to that, quality management of research in STI; partnership between R&D, industry and Government and intellectual property and rights are some of the key aspects in a comprehensive management of STI that need to be introduced in the STI culture of the country.

It is often argued in Tanzania that research results are neither properly documented nor properly addressed to national and societal needs. The latter is a frequently cited problem in many developing countries, which this Review does not fully agree with, as research topics do follow national priorities. The problem for the use of research results must be sought in other reasons.

Patents (and other IPR forms) are a traditional source of measurement of the national capacity for technology development and innovation. There are two elements need to be taken into account when dealing with patents as indicators to innovation. The first is the institutional setting, and in the case of Tanzania, the national patent office is considered as one of the institutions to be strengthened within the different science and technology plans. The second element is the capacity of researchers and technologists to actually create patentable products. Until now this process has been very weak as evidenced from data from the patent office and other sources.

Tanzania ratified its adhesion to the Harare Protocol and implementing Regulations on 1st September 1999. The Protocol empowers the African Regional Intellectual Property Organization (ARIPO – www.aripo.org) to grant patents and to register utility models and industrial designs and to administer such patents, utility models and industrial designs on behalf of the Contracting States in accordance with the provisions of the Protocol, through the Secretariat. By 2008 ARIPO had received 435 applications (WIPO, 2010), all of non-residents. Although the statistics at ARIPO could not be disaggregated, and thus the number of applications originated in Tanzania cannot be determined, it is evidenced that no resident patent was received from the country.

Limited awareness of IPR and inadequate enabling environment—including non-use of patents in research activities among scholars/academics and industrialists—greatly affects research in terms of its economic contributions and the value added in new products and processes, and licenses with royalties. There is no proper licensing system in place aimed at effective commercialization of research results/innovations. As such there has been limited or else complete lack of technology transfer that could have spurred the process onto grassroots innovations and/or spin-off companies from R&D institutions. Thus, there is a need to have a clear legislative provision and a regulatory policy for an institutional mechanism in support of technology licensing in the country.

Finally, there are only limited efforts in attracting the private sector, individuals, business people, trade unions and community organizations into contributing significantly to the

national STI effort by way of funding or shared sponsorship of research programs. Additionally, the STI policy needs to advocate for regional and international collaboration in STI funding as well.

3.3. Research and Innovation in Key Sectors

3.3.1. Agriculture and Natural Resources Sectors

In the agricultural (including livestock and fisheries) and the natural resources and tourism sector, there are about 32 organizations of which, a sample of the larger public R&D centres, enjoying some autonomy from the parent Ministry of Natural Resources and Tourism, are the Tanzania Wild Life Research Institute (TAWIRI), the Tanzania Fisheries Research Institute (TAFIRI) and the Tanzania Forestry Research Institute (TAFORI), stand out. Under private operation are the Tea Research Institute of Tanzania (TRIT) and the Tanzania Coffee Research Institute (TACRI). Some groups of farmers, especially large-scale and commercial farmers, have been organized into cooperatives and associations, such as the Tanganyika Coffee Growers Association, cooperative unions in coffee-growing areas, and tea and sisal growers associations.

Research activities in agriculture have picked up in terms of generating new seed varieties and obtained other isolated important results; however, the overall impacts of R&D projects are still minimal. Very few farmers, especially in the smallholder sector, have adopted the technologies developed by the public R&D centres. There are at least two major reasons for this trend, some of the new varieties meet productivity criteria but do not meet consumer taste and preferences criteria because researchers paid too much concern to enhanced productivity and output and did not take into account consumer preferences and inadequate dissemination of research findings and weak extension services.

In the sector, major decisions regarding research are made through the Directorate of Research and Development (DRD) in the Ministry of Agriculture and Food Security (MAFS). The directorate also plans and executes research and disseminates research findings to those involved in agricultural production by providing extension services offered by another department within the ministry. DRD operates through a network of research institutions, centres, and substations that covers the main areas of crop research. There are seven zonal research and training centres located in seven agro-ecological zones, which are responsible for applied and location-specific adaptive research.

Extension services in Tanzania have generally been understood as the transfer of agricultural technologies from experts (including progressive farmers) to farmers and other stakeholders such as livestock keepers. These services are used by the DRD and its research institutions to transfer well-proven technologies from research institutions to farmers. The services have been the object of much debate and criticism among stakeholders in the agricultural sector. The weak links between research institutions and their partners, namely extension services and farmers, have been widely recognized as one of the main reasons why the agricultural technology systems in Tanzania, and many countries in Africa, are ineffective and inefficient.

The sources of funds for R&D in agriculture include the central government, foreign donors, local government authorities, levies, contract research, revenue retention, and cost recovery. Most R&D is being funded by external sources. About 80% of expenditures made by R&D institutions have come from donors. The government covers mostly salaries and other

routine, non-developmental expenditures. In the past years, funding by both government and external donors has been reduced.

In 1994, the government launched two sources of agricultural research funds: the National Agricultural Research Fund (NARF); and the Zonal Agricultural Research Fund (ZARF). The NARF has been used to finance research and links that cut across several agricultural zones. It has also been used to finance collaborative research that links government researchers and academic researchers. The fund has demanded high-quality research proposals from applicants. As of June 2002, a total of barely $342,508 had been released. The NARF has not been built as fast as had been anticipated because there has been a failure to attract additional research funding from other sources. Lengthy review procedures for proposals have contributed to the delay.

ZARF has been used to fund zone-specific research as part of decentralization, empowerment of local stakeholders to fund and influence research, and a move toward financial sustainability. District councils and local stakeholders are encouraged to contribute to this fund. Although ZARFs contributed by the local government authorities and the private sector are becoming an important source of research funds, the contributions are still small.

Starting in 1994, the agricultural research institutes were allowed by the government to retain income generated from the sales of produce and services, user fees, rentals, and consultancy contracts. The amounts collected increased from TAS 59 m in 1994–95, to TAS 271 m in 1999–2000, and then declined somewhat to TAS 185 m in 2001–2.

To promote the use of agricultural inputs, the government has established the National Agricultural Inputs Trust Fund to provide loans through local banks. The results of different analyses attempting to relate the relevance of research to source of funding, shows no significant correlation between successful or unsuccessful projects and sources of funding. Furthermore, some projects that were termed very successful by the R&D organization were considered highly unsuccessful from the farmers' perspectives.

Public-private partnerships are beginning to emerge in the landscape of R&D institutional arrangements in agriculture. For example, collaboration between ARI (Agricultural Research Institute) Mlingano (a public R&D organization) and Katani Ltd. (a private organization owning sisal estates and sisal processing factories) is a public-private partnership. The project, which was funded by donors, took an innovative approach. Instead of the research funds being managed by ARI Mlingano, they are being managed by Katani Ltd., the main beneficiary of the research outputs. The proposal for the research grant was jointly prepared by Katani Ltd. and ARI Mlingano. The evidence suggests that under such arrangements the R&D system is more responsive to the needs of the farmers compared with the situation in which government funds are managed by public research institutions.

Two experiences stand out in the private sector initiative as coffee and tea growers associations now own and manage coffee and tea research institutes. The Tea Research Institute (TRIT) has a very efficient system for identifying priority areas, conducting R&D, and disseminating information to end users. Since privatization in 1996, annual output has increased from 15,000 tons to 28,000 tons – an increase attributed to research work. What emerges from existing analysis is that farmers, even the smallholder peasant farmers, are willing to contribute to research activities when they have been impressed by the outcomes of research. The successful privatization of tea research has been replicated for coffee and cashew nuts. In the former, TaCRI was established in 2000 and became operational in September 2001.

3.3.2. Industrial Sector

In the industrial sector, there are 10 main public R&D organizations, of which TIRDO, TEMDO, CAMARTEC, and the Tanzania Bureau of Standards (TBS), stand out. Under private operation is the Tanzania Technology Development Organization (TaTEDO). The industrial R&D system in Tanzania is a relatively young compared with agricultural and medical research.

With the exception of university-based institutions and NGOs such as TaTEDO, all other industrial R&D institutions operate as parastatal organizations under the Ministry of Industry and Trade (MIT), which is responsible for major activities and initiatives such as the development of infrastructure, administration and personnel, and appointments of Board members, chief executives, and other top-level appointments to managerial positions.

TIRDO promotes technology development for manufacturing industries. TEMDO promotes engineering services and provides technical training to enterprises. The Institute of Production Innovation was founded in 1981 at the University of Dar es Salaam to undertake product innovation, transfer to industry, and technical consultancy for enterprises. The TBS was established in 1976 under the Ministry of Industry and Trade to manage metrology standards, testing, and quality standards in Tanzania. These institutions chronically suffer from lack of funds either coming from Government or donors or the reduced commercialization of their products.

Recent developments, including changes in ownership of industries and a more competitive environment, have not been translated into increased demand for outputs of industrial research and development. The relevance and effectiveness of industrial research is still not an issue in most organizations and the demand side suffers from the effects of the trade liberalization regime, as industry is free to import its inputs and other requirements.

Appropriate communication channels are important for translating research results into something tangible. The three most commonly used communication channels are extension services, demonstrations, and participation in trade fairs and shows. It is not clear from existing analyses whether these adopted communication channels are to blame for the observed ineffectiveness, and other factors also intervene: shortage of potential entrepreneurs to take up commercial production; lack of marketing outlets; low levels of technical skills; poor links between R&D institutes and manufacturers, and financial institutions; and lack of effective demand for developed prototypes.

In spite of many limitations, there are some research projects that have demonstrated high levels of effectiveness to the beneficiaries. Institutes doing this work are engaged in more or less similar projects. Most were undertaken during the 1980s when the economic conditions were characterized by an acute shortage of goods that called for local substitutes. In addition, increased demand for energy and its impact on the environment had necessitated research on energy-saving measures including the design of energy-efficient cookers.

In more recent years, and as a way to create manufacturing capacities through technology and innovation development activities, particularly in SME, the College of Engineering of the University of Dar es Salaam established in 2004 the Morogoro Business and Technology Incubator. This effort was made possible under a joint project initiated in 2002 with the cooperation of the Small Industries Development Organization, the Ministry of Industry, the Tanzanian Gatsby Trust and the Carnegie Corporation of New York. The Incubator has at present 19 clients/tenants (UDSM, 2007) distributed in food sector companies. At present all

19 companies are active in the market with their products, although it was not possible to find financial data to support any of their success stories.

From the point of view of the manufacturers, the relevance and effectiveness of research projects is a function of the environment in which they are operating and the costs of procuring and using knowledge and information from R&D institutes. Many industrialists agree they are operating in a competitive environment, but except for those firms owned by multinational corporations with centralized R&D abroad, not a single company reports in-house research activities. Technical production problems are usually addressed through routine preventive maintenance. Asked how useful R&D institutions were in addressing their problems, more than half experts normally respond negatively. Those who respond are mainly large-scale and local, and they cite consultancies and commissioned research with R&D institutes.

More important, 71% of stakeholders have no contact with R&D institutes, and those who had contact had initiated it themselves. This confirms the weak links between R&D institutions and the productive sector, which has had a negative impact on the effectiveness of industrial research. It appears that consultancies may be a way to establish links between industry and R&D institutions. R&D institutes must aggressively advertise the kinds of industrial problems they can solve. This has two implications. First, investment in basic research will be reduced in favour of applied research activities that are currently in demand. Second, only those industries that can pay will be served by the R&D system.

With the exception of consultancies on specific problems, the knowledge and information generated from industrial research is not industry-specific. Products and processes can be easily copied at a fraction of original R&D investment by anyone with relevant technical knowledge. Small-scale engineering firms have been good at producing products based on designs from R&D institutes; therefore, they under-cut R&D institutes that want to commercialize the production of their own prototypes.

In funding, there is overdependence on the government, and donor funding is much more targeted. TaTEDO is a modest attempt to privatize industrial research. Founded in 1990 as a not-for-profit NGO, TaTEDO 'is a coalition of individuals, professionals, farmers, community-based organizations and enterprises involved in the development and promotion of renewable energy systems for enhancing environment and socio-economic development of communities in Tanzania'. The only difference between TaTEDO and the other research institutes is that it does not receive government funding. However, like other research organizations, donor funds support the core of its activities, and its remaining funds come from consultancies and the marketing of its products to individuals, hospitals, schools, and church groups.

3.3.3. Health Sector

In the health sector there are about 11 organizations of which the National Institute for Medical research (NIMR) is important and reports to the Ministry of Health. Under private operation, an outstanding research centres is the Ifakara Health Institute (IHI).

NIMR is both a clearing house for medical research and a coordinating agency for resource mobilization for R&D activities in the health sector. In addition, it provides a link between research institutions and the government. With its headquarters in Dar es Salaam, NIMR oversees research activities in three centres and three research stations: Amani Medical Research Centre (AMRC); Mwanza Medical Research Centre (MMRC); Ifakara Health

Research and Development Centre (IHRDC); Tabora Medical Research Station; Tukuyu Medical Research Station; and Muhimbili Medical Research Station. There are also teaching hospitals that conduct research activities: Muhimbili Medical Centre in Dar es Salaam; Kilimanjaro Christian Medical Centre (KCMC), Moshi; Bugando Hospital, Mwanza; and Ifakara Health Research and Development Research Centre (IHRDC) at Ifakara.

Centralization makes it possible to develop the critical mass of staff and resources needed to sustain research in modern health sciences. Within present arrangements, by 2002, NIMR had 53 research scientists (most with PhDs), 33 laboratory technicians, and 13 top-level administrators.

There are some inherent limitations with such an arrangement. The most common complaint from beneficiaries is the lack of involvement by medical professionals working with hospitals. It is felt that medical R&D lacks an appropriate dissemination forum or feedback mechanism (in spite of the existence of the TANHER Forum /[3]) that could increase the usefulness and effectiveness of medical research. In front of this limitation, NIMR has embarked on several new approaches to disseminate its research results, in addition to a health research bulletin, annual reports, and annual joint scientific conferences, radio and television have been identified as effective communication channels. Regular media workshops are held to bring together both print and broadcast media to discuss the results of medical research.

Decades of research on a wide range of diseases like malaria, filariasis, plague, schistosomiasis, and more recently on HIV/AIDS has been undertaken, and there are other numerous diseases that could be the subject of interesting research. Many researchers are of the opinion that malaria and HIV/AIDS are priority areas for medical research in Tanzania that warrant additional resources. In addition, more than two thirds agree that research in these areas has been very effective in terms of both knowledge generation and utilization.

A large number of medical practitioners (80% in the study of Mmawila) believe that the research and services provided by R&D institutions are relevant to their work. They believe that this research has: improved healthcare quality; led to better patient management; helped prioritize health problems; and helped to better understand local conditions.

The Tanzanian government is not only the main sponsor but also the major consumer of outputs from the medical R&D system. Considering the public investments that have been made over the past two decades, it would not expect as many problems in knowledge generation, dissemination, and utilization process, as exist at present. The main beneficiaries of medical R&D (medical service providers, which include publicly and privately owned hospitals and local authorities) experience significant problems in accessing information coming from medical research laboratories, and clinical and field trials.

Although domestic sources account for most recurrent expenditures in health (more than 80%), the development budget is dominated by foreign financing (85%). The share of foreign funding in the total budget has been increasing since 2000, and reached 40% in 2003.

/[3] The Tanzania National Health Research Forum (TANHER) was established in 1999 as 'a consultative and advisory body to policy and decision makers as regarding health research coordination, undertaking, collaboration, dissemination of health research results, and enhancing utilization of research results for policy and decision-making'. The initial grant of $200,000 was provided by the Rockefeller Foundation.

Basket funding has grown from 2% of the total budget in 1999–2000 to 19% in 2001–2, and was estimated to reach 28% in 2002–3. Fears have been expressed that as donor funds shift away from earmarked basket funding to general budget support, there is risk of diverting resources to other sectors. There are also indications that medical R&D institutions have faced shortfalls in the resources needed for their R&D activities.

In funding, the Health Research User's Trust Fund (HRUTF) was formed in 1996 by the NIMR to enhance demand-driven health research efforts to overcome problems associated with communicable diseases, pregnancy and delivery, malnutrition, chronic underfunding of the health sector, and management of the health system. HRUTF addresses health research problems identified by stakeholders. Established with seed money of $177,300 from the Swiss Development Cooperation, it is supported by an annual subvention of TZ50 m from the Ministry of Health.

3.3.4. Social Sciences

 In the social sciences there are several organizations of which the Economic and Social Research Foundation (ESRF), the Research for Policy Alleviation (REPOA), the Tanzania Gender Network Group (TGNP) and the Society for Women and AIDS in Tanzania (SWAAT) stand out besides those existing in some of the larger universities, particularly the University of Dar es Salaam. There are 9 universities where R&D is being undertaken.

The Economic and Social Research Foundation (www.esrftz.org) represents an important and highly recognized organization in this area of knowledge. ESRF is an independent, non-governmental research centre founded in 1994, as a response to the need of developing capacity for policy analysis. The Foundation conducts policy-related research, capacity building programs and policy dialogues. It also undertakes demand-driven commissioned studies.

ESRF focuses on five main themes:

- Growth and wealth creation
- Globalization and regional integration
- Governance
- Social wellbeing and quality of life
- Natural resources management.

An important activity of ESRF has been the launching in 2009 of the Tanzanian Knowledge Network (TAKNET) (www.taknet.or.tz) which provides a forum for exchanging and sharing information on social and economic development. Besides an extensive set of publications, the Foundation produces (since 2009) its Quarterly Economic Review and Annual Reports (since 2005).

Chapter 4

Higher Education Institutions in Tanzania

4.1. The Non – University Education: Overview

During the past years, Tanzania has made important inroads into the improvement of primary and secondary education, through the adoption of the Education Sector Development Programme (ESDP), initiated in 1997 and revised and updated in 2001 and 2008.

The revised version of the ESDP 2008 - 2017 takes into account the Primary Education Development programme (PEDP), the Secondary Education Development Programme (SEDP) (2004-2006), the Folk Education Development Programme (FEDP) (2004-2009), the Joint Assistance Strategy for Tanzania (JAST) principles and has been up-dated to respond to the findings of the Education Sector Reviews (2006-2009).

It is recognized by several studies (see for example UN 2008), that Tanzania has made progress towards the achievement of Universal Primary Education. There has been a rapid increase in primary school enrolment since the launching of the Primary Education Development Plan (PEDP) in 2001, and the abolition of school fees. The Net Enrolment Ratio rose sharply from 59 % in 2000/01 to 97 % in 2006/7 /[4]. In recent years pre-school education enrolments also increased significantly. The Net Enrolment Ratio for secondary education for Form 1 to 4 also increased after the launch of the Secondary Education Development Program (SEDP).

Achievements of Secondary Education Development Program SEDP include increased enrolment in secondary education (Form 1-6) from 432,599 in 2004 to 1,466,402 in 2009, Gross Enrolment Ratio (GER) increased from 11.7% in 2005 to 31.3% in 2009, while Net Enrolment Ratio (NER) increased from 10.1% (2005) to 27.8% in 2009. Transition rate from primary to secondary level also increased from 36.1% in 2004 to 51.6% in 2009 while the number of secondary schools increased from 1,291 in 2004 to 4,002 in 2009. These achievements have had direct impact on the capacity of higher education to absorb or enrol the expanded outputs from lower levels.

The Technical, Vocational Education and Training (TVET) sub-sector covers all forms of organized vocational education and training. The Resolve Report defines it as "the full range of applied learning at low- mid- and high-skill levels". Enrolment in Vocational Education and Training increased from 79,429 students in 2006 to 120,655 (45% women) in 2007/08 (52% increase). In terms of relevance, according to available data 31,462 (FDCs 2007) graduates (43% women) were provided with employable skills.

The Government is in the process of reviewing and reforming the Vocational Corporate Plan (VCP) into the Vocational Education Development Plan (VEDP).The Government's Time Bound Program (TBP) supported the revision of the COBET curriculum to integrate child labour issues, and the re-integration of children who had suffered from the Worst Forms of Child Labour (WFCL) into primary schools through COBET and VET centres. The UN Joint Program, to be referred later, will build on these positive achievements in responding to the

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[4] Basic Education Statistics in Tanzania (BEST), 2002-2007.

need to establish a knowledge-based training for young learners in secondary and higher education, enhancing innovation capabilities and in developing an entrepreneurship spirit, in partnership with universities, professional bodies and the private sector.

The Teacher Education Division within MOEVT has the mandate to educate and train teachers through pre-service and in-service for pre-primary, primary and secondary school level education. There are 34 public teacher training colleges (TTS's), 19 colleges train certificate-level teachers for primary level education and 15 colleges train diploma level teachers for secondary schools. In addition to the Government run teacher training colleges there are 34 private colleges.

The expansion of primary and secondary education has put much pressure on the Teacher Training Institutions. The total enrolment in TTIs declined from 32,652 (48% female) in 2004 to 21,888 (48% female) in 2008 (-33%)[5]. Efforts have been made by Government resolve the situation, including the introduction of a two-tier system for the teacher education curriculum and the use of induction teachers but have had limited impact. Teacher shortage at all levels of the system still persist and are a challenge, there is therefore a need to increase the capacity of TTI's and to make the profession more attractive and to improve the quality of training.

At the same time there is no national system for in-service training and most primary teachers have no access to any additional training after they start work as teachers. A comprehensive holistic approach to pre-service, in-service and continuous professional development is required to effectively resolve the problem. Hence teacher education for quality teaching and learning is a major activity area of the Joint Program.

In 2007, the government embarked on a comprehensive undertaking to formulate the Teacher Development Management Strategy (TDMS), together with master plans for Higher Education and Science and Technology, the Science Education Policy and the adult education strategy and more recently the Integrated Program for Post Primary Education, which offers alternatives to formal secondary education.

The strategy is broad and cuts across all levels and programs, including higher education, vocational and technical education, adult and non-formal education. It identifies 13 strategic objectives to address issues of adequacy, quality, professionalism and the management of teachers. Within the TDMS context and to complement the strategy, an in-service teacher training strategy and program for primary teachers is currently being developed. This will be further supported by the Joint Program, as will the review of the Primary Teacher Education.

Lifelong learning' (LL) means continuous education and training, which in Tanzania's context includes basic and post literacy, out-of-school education, post primary, vocational training short courses, folk development short courses, life-skills and livelihood-skills training[6]. Categories of LL include Integrated Community Based Adult Education (ICBAE), Complementary Basic Education in Tanzania (COBET), Non-formal non-certified programs, apprenticeships and informal sector programs such as occupational safety and health programs run/coordinated by VETA. Also included are Open and Distance Learning (ODL)

/[5] June 2008, situation analysis
/[6] A Conceptual Framework for Lifelong Learning is currently being finalized and will be officially presented during a forthcoming international conference on 'Challenges of Lifelong Learning in the 21st Century', to be held in Dar-es-Salaam, Tanzania).

for secondary education (run by the Institute of Adult Education), and programs offered by the Open University of Tanzania.

The lack of a coordinated, data collection system in LL explains why data on enrolment and other key indicators is currently not available. In COBET and ICBAE, the only LL categories where BEST data is available, enrolments have dropped by 50% and 37% respectively, since 2006)[7]. In the case of COBET this reduced enrolment in alternative approaches was an intended consequence of UPE, however many pupils are still not completing primary education so the need for alternative approaches remains.

A national strategy for 'lifelong learning' (LL) is in process as part of implementation of the ESDP[8]. However, the progress in LL is critically undermined by the incoherence and coordinated approaches to planning. Reliable data, evidence-based planning, and systematic response to challenges in this area are required. To this effect, a decentralised Lifelong Learning-Management Information system will be included in the overall framework of the ESMIS Programme.

The challenges of effective planning, management, monitoring and appraisal in the education system are wide. The absence of evidence-based planning at many levels, linked to the lack of indicators for a performance appraisal system undermines the efficiency of the system. In response to this challenge, the Government launched the Education Sector Management Information System (ESMIS) Program (2007-2010).

ESMIS Master Plan focuses on (a) strengthening the existing Basic Education EMIS and harmonizing it with other sub-sector MIS (b) strategic capacity development for M&E at various levels of the sector. A key feature of the latter is a 'learning by doing' methodology, comprising of Education Sector Analysis (ESA),with the aim to enhance overall sector performance through evidence-based planning, identifying elements to facilitating making necessary choices in terms of trade-offs. The education sector analysis will strengthen continuous sector performance reporting, which was recently introduced through the Education Sector Review (ESR).

By 2010, the ESMIS Master Plan, which constitutes a key component of the UN Joint Program, is expected to be mainstreamed into ESDP and be part of the ESDP Monitoring and Evaluation Plan.

The positive achievements made by the sector and Government efforts are undermined by several problems, including acute shortage of qualified teachers, disparities within and between geographical areas, income, location and gender, which have revealed the problem of equity in enrolment and completion rates as well as a decrease in student performance, low interest in science subjects, low capacity for quality assurance, and weak linkages between the sub-sectors of primary, secondary, Technical and Vocational Education and Higher Education.

The challenges facing the Technical, Vocational Education and Training sub-sector include: coordination, coherence, relevance and quality, linkages within the sub-sector and with the other sub-sectors and the world of work, synergies between formal and non-formal TVET

/[7] Based on BEST June 2006 and June 2008.
[8] "Strengthening the provision of opportunities for lifelong learning to promote economic growth" (ESDP p.12).

providers. Relevance of the curriculum/programs in terms of relationships with the labour market and in anticipation of the economy growth requirements are fundamental concerns to be addressed.

Delivery of quality education and training is largely governed by existing policies and their implementation strategies, and considering the many areas where such implementation has been inadequate, Government has envisaged and Education and Training Policy (2009) (currently under review) so as to evolve a comprehensive national education and training policy. The key objectives of the Education and Training policy are:

- To improve the quality of education and training at all levels of education and training

- To improve the learning and teaching environment at all levels of education

- To improve the capacity of education and training institutions and governance agencies in order to meet existing needs

- To provide quality education and training in diversified fields in order to meet market demands

- To promote the use ICT for teaching, learning and communication at all levels of education

- To broaden the scope of funding sources for education and training

- To improve access and equity in provision of education and training

- To undertake research in order to guide evidence based decisions and development of new knowledge

- To undertake monitoring and evaluation in order to assess performance and provide a basis for instituting corrective measures were required.

Further, the Medium Term Strategic Plan (MTSP) 2007/08 – 2009/10 of the Ministry of Education and Vocational Training currently under review is designed to articulate the Government's vision for the development of Tanzania's education and training system. It is a conscious process in which MOEVT assesses its current state of affairs and the likely future condition of its environment under which it will operate. Thus, MTSP provides strategies and sets specific priorities for the sector. The key areas which have been identified are: enrolment; access and equity, quality, efficiency in education management, cross-cutting issues, and education management information system.

Considering the general situation, it is important to note that spending in education has also increased progressively between 2003/4 and 2007/08, as evidenced in Table 1

In the current education sector context, the UN plays an important role in national level policy dialogue. It is engaged in the education sector reviews, and takes part in the Performance Evaluation Review (PER) and thematic working group discussions in the MOEVT in accordance to a division of labour agreed within the Development Partners' Group in Education. The UN has provided the Secretariat to the Development Partners' Group in Education since January 2008, which has enhanced the influence of the UN agencies within the DPG. Both UNESCO and UNICEF are actively involved in the DPG meetings and in the Thematic Working Groups in MOEVT, including the key Basic Education Development Committees. The UN agencies also have district level engagements, which will help ensure synergy between the proposed work at the national and sub-national levels.

**Table 1: Trends in Budgetary Funding of Education Sector
by Level (Million Shillings)**

	2003/4	2004/5	2005/6	2006/7	2007/8
Primary Education	146,145	385,542	390,974	491,243	544,220
Secondary Education	32,184	91,481	104,483	119,987	174,227
Vocational Training	3,650	4,672	8,926	10,654	18,978
Teacher Education (MoEVT)	12,371	5,653	8,540	10,438	19,257
Administration	20,379	21,926	27,597	45,769	30,405
Folk Development	1,833	1,506	2,360	2,568	3,132
University Education	69,254	73,175	118,359	181,784	264,343
Technical Education	6,342	6,618	11,131	14,493	14,289
Other Tertiary	15,554	15,576	20,186	21,497	29,343
UNESCO Commission – MoHEST	260	280	383	322	381
Science and Technology –MoHEST	2,215	1,990	3,254	5,535	5,134
Administration - MoHEST	8,070	2,252	4,932	7,726	3,729
Total education	318,256	610,671	701,124	912,015	1,107,437
% of total Government budget	12.6%	18.7%	17.4%	18.8%	18.3%
Total Government budget	2,516,900	3,257,600	4,035,100	4,850,600	6,066,800

Source: 'Resource Allocation and Challenges of Education Reform in Tanzania', paper by Dr Mussa Assad (UDSM) and Samwel Kibaja (MoF), presented to Education Sector Review Workshop, October 2007

The UN system in Tanzania is now committed to delivering a joint program that will have a significant impact in improving the quality of the national education system. The JP on Education will assist Tanzania in its progress towards achieving the EFA MDG and MKUKUTA goals, by supporting major reforms and structural changes in education, through addressing fundamental issues of planning, management and monitoring and evaluation, which when addressed should lead to enhanced access and equity, quality, efficiency and sustainability. In addition to supporting the Education Sector reform strategic objectives, now reorganized in the revised ESDP. The JP will be aligned to the priorities expressed in the 2007 Aide Memoir and 2008 Road Map, namely strengthening data & performance reporting, strengthening planning and budgeting, increasing access to and quality of education services, and Science, Technology, and Vocational Education.

The main expected outcomes of the Joint Program are: an Enhanced national and sub-national capacities for evidence based planning, policy development and decision making and an Enhanced capacity to deliver quality education by 2010.

While the focus of this Review are HEI, an analysis of the primary and secondary levels would tend to indicate that the quality provided at this educational level together with the rather scarce incentives existing for the study of science, that prepare students to enter to study STI related subjects at HEI, do influence the performance of these institutions in the

STI system. By commission of UNESCO, the ESRF is at present conducting a Needs Assessment Study Report for Science Education that should shed light on this issue.

4.2. Higher Education

4.2.1. Overview

Higher education in Tanzania has suffered enormous changes in the past decade. In 1995 there were only three public universities, while today there are 32, 8 public universities, 3 public university colleges, 12 private universities and 9 private university colleges, all with a student population of around 117,000. Table 2 provides a list of 31 of the above mentioned organizations.

Table 2: Universities and Enrolment Figures

S/N	INSTITUTIONS	2007/08			2008/09		
		F	M	T	F	M	T
1	University of Dar es Salaam	5,297	9,502	**14,799**	5,202	9,001	**14,203**
2	Sokoine University of Agriculture	957	2,247	**3,204**	1,003	2,616	**3,619**
3	0pen University of Tanzania	5,920	19,909	**25,829**	6,768	22,167	**28,935**
4	Mzumbe University	1,466	2,071	**3,537**	1,785	2,303	**4,088**
5	Muhimbili University of Health and Allied Science	374	1,057	**1,431**	664	1,501	**2,165**
6	Ardhi University	281	1,321	**1,602**	293	1,615	**1,908**
7	State University of Zanzibar	479	526	**1,005**	487	548	**1,035**
8	Dodoma University	328	788	**1,116**	2,183	5,154	**7,337**
9	Moshi Univ. College Coop and Business Studies	429	945	**1,374**	754	1,314	**2,068**
10	Dar es Salaam University College of Education	1,246	2,080	**3,326**	1,484	2,044	**3,528**
11	Mkwawa University College of Education	453	631	**1,084**	652	1,247	**1,899**
12	Hubert Kairuki Memorial University	187	255	**442**	311	220	**531**
13	Int. Medical and Technological University	35	133	**168**	264	437	**701**
14	Zanzibar University	510	840	**1,350**	616	861	**1,477**
15	St. Augustine University Tanzania	1,459	2,706	**4,165**	2,386	3,858	**6,244**
16	St. Johns University Tanzania	291	500	**791**	717	1,155	**1,872**
17	University of Arusha	304	725	**1,029**	279	587	**866**
18	Mount Meru University	117	150	**267**	298	338	**636**
19	Muslim University of Morogoro	245	409	**654**	66	93	**159**
20	Agha Khan University	297	464	**761**	145	69	**214**
21	Teofilo Kisanji University	300	594	**894**	594	1,190	**1,784**
22	Ruaha University College	369	595	**964**	461	751	**1,212**
23	Weil Bugando University College	307	407	**714**	183	355	**538**
24	Mwenge Univ. College of Education	51	139	**190**	205	391	**596**
25	Iringa University College	878	1,371	**2,249**	1,231	1,700	**2,931**
26	KCM College	115	119	**234**	326	679	**1,005**
27	Makumira University College	365	553	**918**	505	654	**1,159**
28	Tumaini University DSM College	600	728	**1,328**	672	782	**1,454**
29	Steph Moshi Mem Univ College	146	250	**396**	202	291	**493**

30	Sebastian Kulowa University College	55	83	**138**	156	282	**438**
31	University Col of Educ Zanzibar	81	132	**213**	120	310	**430**
	TOTAL	**23,942**	**52,230**	**76,17**	**31,820**	**63,705**	**95,525**
	% of female students	**31.4**			**33.3**		

Source: HEDP 2010

Table 3 shows the overall higher education sub-sector budget for the next 5 years and Table 4 highlights the indicative budgets for the specific activities to be implemented under HEDP (to be described further on).

The overall budget requirement for higher education sub sector for the next 5 years is estimated at TAS 3,603 billion, of which Government is committed to provide a total of TAS 3,178 billion, the rest from current Development Partners. The financing gap in HEDP is expected to come from other new Development Partners, Financial and Social Security institutions in a form of grants and soft loans. This gap is also expected to be filled through Public–Private Partnerships and intensified internally generated incomes.

Table 3: Overall Budget for the Higher Education sub sector for the period 2010 to 2015

ITEM	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	TOTAL (TSh)	%
Government contribution								
Recurrent expenditure[1]	342	410.4	492.48	590.97	650.1	650.1	2,794.05	77.5
Local development expenditure	46.84	56.21	67.45	80.93	89	89	382.59	10.6
Development Partners contribution[2]	**49.97**	**54.97**	**60.46**	**60.46**	**60.46**	**60.46**	**296.81**	**8.2**
Total funds available	**438.81**	**521.58**	**620.39**	**732.36**	**799.56**	**799.56**	**3,473.45**	**96.4**

Table 4: Required Funds for the Implementation of HEDP

	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	TOTAL (TSh)	%
Institutional reforms	0	2.43	2.22	1.557	0.36	0.10	6.67	-
Service delivery	O	100.95	144.42	108.37	80.56	34.45	468.75	-
Sustainability mechanisms	0	1.16	1.31	0.68	0.6	0.6	4.34	-

Program coordination	0	1.36	1.85	1.38	1.02	0.43	6.05	-
Contingencies	0	1.06	1.50	1.12	0.83	0.35	4.85	-
Total program budget *3	**0**	**106.96**	**151.29**	**113.10**	**83.37**	**35.95**	**490.67**	**13.6**
Overall H.E Budget requirements **	_	**545.71**	**672.87**	**733.58**	**815.78**	**835.51**	**3,603.45**	**100**
H.E Budget deficit or Financing gap		*24.13*	*52.48*	*1.22*	*16.22*	*35.95*	*130*	*3.6*

Source: HEDP (2010)
Notes:
[1] Includes student loans (Shs 197 billion) each year for the entire period
[2] Figures do not include DPs contribution to Government budget through GBS
[3] Does not include extra student loans to be required due to increased enrolment

4.2.2. Governance

In the past years, important institutional changes have taken place in order to cope with the evolving context. One such change has been the establishment in 2007 of the Directorate of Higher Education within the realm of the Ministry of Education (www.moe.go.tz), in substitution of the higher education responsibilities previously entrusted to the Ministry of Higher Education, Science and Technology (at present the Ministry of Communications, Science and Technology). Also in this period three agencies were established, namely: The Tanzanian Commission for Universities; The Tanzanian Education Authority; and the Higher Education Student Loan Board.

The Directorate of Higher Education in the Ministry of Education

The Directorate has as its main functions the development of policies and the definition of guidelines and regulatory frameworks for higher education, also the monitoring and review of the performance of HEI, programs and project implementation. It also oversees and coordinates the three agencies under the aegis of the Ministry.

The Tanzanian Commission for Universities

In June 2005 the Parliament enacted the "Universities Act, 2005" as the main instrument for guiding and regulating the higher education sector of Tanzania. The Act establishes the Tanzanian Commission for Universities entrusted with a large set of functions including:

- Advise the Minister of Education on any aspect or matter of university education
- Audit the quality assurance mechanism of universities
- Provide general guidance and monitor the administration and performance of universities, defining student transfer procedures and others
- Set standards, accredit and register all universities, including the issuance of permits for new universities and recommendations of upgrading or downgrading the status of universities
- Oversee the provision of funds, and several other functions

In general the Commission deals with the academic activities of universities, and under the Act has no specific mandates on university research or the university's "third mission". The Act also establishes an Accreditation Committee, a Grants Committee, and Admissions Committee, as advisory bodies to the Commission.

The Accreditation Committee sets the general standards of quality and quantity of contents of programs and modes of execution, it is also charged in the promotion of quality assurance and the definition of linkage programs with short-term and long-term national development objectives, as well as the involvement of stakeholders in the fostering research and expert public service or consultancy and modes of execution.

The Grants Committee advices the Commission on funding and of distribution of public funding among public and private universities, assess use of funds, provides guidelines for budgeting, regulates fees charged by universities.

The Admissions Committee advices the Commission on matters concerning admission of students to universities, setting up conditions for admissions, providing a central admission service, promoting cooperation among universities and disseminating information

The Act defines the types, categories, awards and staff designations at universities, as well as defines precise guidelines on the establishment of a university. It also defines the governance mechanisms of universities, as well as determines convocations, staff associations and students associations, administration and welfare.

As part of a Rolling Strategic Plan 2009/10 – 2013/14, a Central Admission System was created. The existing admission procedures into HEI require applicants to collect and submit applications to the respective individual organizations. This procedure has led to problems during the process, including applicants having admission to more than one organization or program, and leading these to run under capacity. Considering such situation, it was decided to use a central system under TCU, which will be applicable for the first time in the academic year 2010/2011. For public universities the system is compulsory but for private HEI it is voluntary, but quite a few have indicated that they will use the system.

The Tanzanian Education Authority (TEA)

The TEA was established in 2001 through the Education Fund Act No. 8 of 2001 as a public organization whose main objective is to support schools, colleges, universities by providing grants and soft loans from its Education Fund, for the improvement of quality, equity and access in education at all levels. Grants include text books, laboratory equipment, while loans are addressed to infrastructure development. In 2009 the total government allocation of funds amounted to TZS 5.7 billion. Other sources of funding include voluntary contributions, fees and others amounting to TZS 1.3 billion. This same year the TUA supported 114 projects amounting to 3.5 billion, of which around 1.5 billion were destined to universities. This is an important organization in the education system which needs to be enhanced further

The Higher Education Student Loans Board

The Board was established in 2004 for the purpose of issuing loans to poor and needy students (with no economic means to pay for the cost of their studies), which secure admission to study in accredited higher learning institutions that award higher diplomas and degrees. The financial assistance cover tuition, research expenses, field expenses, special

university requirements, meals and accommodations, books and stationary expenses, the first three partially or full, and the latter three full expenses. Students can of course opt for other means of support, in particular those that stem from bilateral agreements, Commonwealth scholarships, and private scholarships.

Due to increasing demand on funding, Government introduced already in 1992 a "cost sharing" process which includes the previously mentioned loan scheme. The impact of the process permitted an increase in enrolment from 23,126 students (2003/2004) to 95,525 (2008/2009).

4.2.3. Situation of Higher Education

The situation of Tanzania's higher education system has been analyzed extensively by many authors (see bibliography at the end of the Report). Here, some of the main characteristics of present higher education system, as reported by the HEDP (2010) are resumed:

- There have been a number of efforts, expressed in strong political will, aimed at providing better quality higher education, and as a consequence there has been a significant improvement in HEI governance. Additionally, the government is providing financial assistance to institutions and students. For instance, over the past two years, the overall Ministry's share of higher education budget (in relation to MoEVT budget of 5.3% of the total national budget) has greatly increased from 56% (2008/09), and 70% (2009/10).

- Although the budget for higher education appears to be increasing, most of the funds (50%) have been allocated to student loans. This has deprived HEI of funds required to run them more efficiently.

- In spite of the Government commitment, there are significantly quality related challenges facing higher education, including:

  - Overcrowding: Increase student enrolment has not matched the expansion of academic institutions

  - Inadequate teaching and learning facilities: Teaching and learning facilities and capital development funds have not increased proportionally to enrolment. Further much of the existing infrastructure is old and outdated.

  - Poor learning technique: Most institutions still use traditional old teaching and learning techniques/methods and; students rely/depend heavily on staff lectures.

  - Inadequate supply and use of books and other relevant materials: Most courses do not follow standard textbooks and students do not frequently make reference to textbooks and library materials. In principle, there is scarcity of standardized course outlines, textbooks, and supplementary materials for students to access latest knowledge.

  - Inadequate and under-qualified staff: The ratio of staff/students in most programmes in Universities is higher than the standard ratio. Also given the fact that University teaching requires doctoral level training and research experience, due to freezing of employment in mid 1990s to early 2000s, in recent years most institutions have been forced to recruit younger staffs that needs further training. With exception of few old Universities, the proportion of staff with PhDs in most Universities is less than 20%.

- Less competent entrants: Most secondary school leavers do not do practicals in science subjects and have language problems especially in English, both written and spoken.

• There are still limited funds allocated to higher education institutions for training institutional staff. In the past two to three decades staff training depended largely on support from Development Partners. This trend is evidently not sustainable.

• Quality assurance is still in its early stages. Currently, not many HEI have in place well organized QA units. The ongoing Inter University Council of East Africa (IUCEA) Program on QA aims at supporting TCU as well as HEI to ensure that QA mechanisms across HEIs in the country are established and fully functional. Likewise, QA should not just end at Undergraduate level but rather should include Postgraduate program also.

• The Universities Act (No.7) requiring every university to operate through its own Charter, has provided (and is providing) a key incentive for improvement.

• There is lack of reliable and consolidated data that allows better use of information in decision-making, instruction, and research in the higher education sub-sector, thus making management weak. For this situation to improve, it is necessary to:

- Provide high quality connectivity to research and educational establishments, which include COSTECH, MoEVT, educational institutions, agencies like TEA, TCU, HESLB, NACTE, TIE, NECTA and Tanzania Library Services;

- Strengthen both EMIS and HET MIS systems in the Ministry and its institutions and agencies, so as contribute to effective management of the higher education sub-sector in managing the financial, personnel, and general administration functions, including students related information;

- Provide electronic and physical support to higher education institutions and libraries for better and efficient knowledge management as well as for gaining access to science and research databases for much wider sharing and use; and

- Enhance the e-learning capacity of classrooms in the institutions through acquisition of networked computers, audio/visual devices and multimedia tools.

• There are many small institutions and operating units. There are universities of less than one thousand students and faculties of less than 15 staff members. There are academic departments with inadequate number and quality of teaching staff. The staff /students ratio is better in Public Universities compared to Private Universities which rely mostly on part time lecturers. Close examination also shows that the ratio of academic and administrative staff is high (1:2-3) and administrative units tend to consume a lot of funds at the expense of academic and research activities.

• There is need to develop a National Qualifications Framework in order to guide the development of a national education and training system which is well integrated/aligned with the existing structures and processes.

• The higher education system has not been very successful in making notable progress towards institutional collaborations and partnerships. Only a few HEIs are currently involved in effective and sustainable partnerships and collaborations with institutions within and outside the country. Such collaborations include inter-library lending, part-time teaching arrangements, exchange programs for students and academic staff and joint research projects. Most of these are, however, not formally institutionalized or mainstreamed into the Institution management system.

- Partnerships are not simply about the mobilization of financial resources for educational institutions but also about alliances that fundamentally feed into the governance processes, the content of learning, the definition of skills and competencies required from the education system, and new collaborative relationships that bring the world of higher education in Tanzania and the world of work closer together. One needs to recognize the increasingly vital role of other stakeholders and partners in the educational enterprise.

- There is need to focus on ICT, which holds immense potential to enable higher education systems to enhance teaching and learning experiences, improve access to educational resources and programs, expand knowledge via distance-learning opportunities, and reduce the costs of education in the long term. For this to happen, an institutional culture has to be created that motivates and rewards institutional collaboration. Such a culture can be created and nurtured by having in place, among others, supportive government policies, an enabling regulatory environment for ICT, strong human resource capacity development, clarity of educational sector objectives and a sustainable funding base.

- HEIs need to work with other national agencies, the industry, representatives of organizations, employers, and other consumers of skills and knowledge to meet the fast changing skills needs, secure appropriate upgrading and ensure responsiveness to the needs of employers. This can go a long way to ensure relevance and high quality of education.

- In the area of R&D, all HEIs are affiliated to COSTECH as R&D institutions. In the on-going reforms on research coordination the role of COSTECH is being enhanced with an increasing trend towards coordination of research funding. Therefore, HEDP should take cognizance of this development by ensuring that HEI forge close collaboration with COSTECH towards implementation of the national research agenda.

- Until 1995, provision of higher education in Tanzania was the sole responsibility of the Government. Involvement of the private sector to provide higher education since then has led to establishment of 20 private Universities and University colleges which absorbs about 26% of the total students' enrolled in higher education. This shows that public-private partnership (PPP) is possible, necessary and a matter that requires encouragement. If properly exploited, it offers a considerable opportunity for HEIs to leverage resources for enhancing provision of services to students and staff. Schemes of this nature are attractive because they can fully recover investment costs and can be self sustained if properly managed. In addition, such schemes offer HEIs to focus on core functions – education, research and community service.

- The country has not achieved synergy and synchrony between investments in the economy and those in higher education. This cannot happen naturally, but rather, through a constant and continuous dynamic process of analysis, alignment and realignment of the two variables over a long period. Countries which are endeavouring to have knowledge and technology driven economies, take specific measures that include:

  - Creation and development of Knowledge Hubs and Communities of excellence in higher learning;

  - Development of specialized universities directly linked to specific industries;

- Development of a coherent policy framework for harnessing new knowledge and technologies including indigenous knowledge (IK) systems;

- Provision of an enabling environment in the form of regulatory framework for higher education and training, providing appropriate financial incentives for institutions and industries to work together;

- Encouraging twinning arrangements between local higher education institutions with world class institutions; and

- Heavy and sustained investment in human capital by educating a large number of skilled professionals in various fields of priority. For instance, the state could focus on some areas of concentration for 10 years.

It is the aspiration of Tanzania to have a knowledge based and technology driven, semi-industrialized, internationally and regionally competitive middle level economy by 2025. To link the higher education sector to the economy, there is a need to improve the supply of qualified science and engineering students by creating a strong A-level system of education by:

- Improving pass rates at A - level, and diversifying the science subjects that are offered;

- Diversifying the curriculum to include new programs for which Tanzania can have a comparative advantage e.g. textile, mining, tourism and leather industry; and

- Creating science learning hubs and centres that send correct signals to students that "Science Matters".

In addition to that, there is a great need to open the academy to the public to promote sustainable partnership between universities, the state, and the private sectors for sharing knowledge, expertise, and facilities so as to rekindle interest in the use of knowledge and technology for economic growth:

Likewise, there is a need to improve linkages between the academy, industry, and the productive sector at all levels. In HEIs, it is important that there should be active collaboration between training, practical experience or apprenticeship, and production. The strategy here will be to create Sector Networks and Committees that regularly meet to review the synergy between training and the productive sector. The relevant activities here will include:

- Select priority growth sectors with quick win impact for priority investment;

- Create private – public partnership clubs or projects, with strong private sector participation;

- Conduct training needs assessment by sectors and levels;

- Review and update, or design new curriculum, according to identified needs; and

- Stimulate public interest in providing funding for research in areas aligned to innovations, production and service sectors.

The development process of any society is invariably closely linked to the integration of Indigenous Knowledge (IK) in socio-economic development systems. Therefore, prosperity

of the national higher education system needs to draw and promote IK experiences by mainstreaming IK into the national higher education set up.

The ultimate goal is to ensure that education provided in HEIs is   holistic in preparing graduates for entry into the labour market and society in general. Thus, in addition to focusing learning in specific areas, education has to mainstream cultural values and ethics to enhance employability and public confidence. These are amongst important issues emphasized in Phase II and III of the Public Service Reform Program that seeks to reform the way government works. They are also issues currently given due weight in the corporate world.

4.2.4. The Higher Education Development Program

Considering the absolute need to have highly skilled and well trained human resources, in March 2010, the Ministry of Education and Vocational Training put forward its proposal for the adoption of Higher Education Development Program (HEDP) (MOEVT, 2010). The Program has identified some key interventions risen from the issues recognized in two previous studies sponsored in 2002 by the then Ministry of Science, Technology and Higher Education on Post Primary Education and Training and Post Secondary Education and Training and the respective Sub Master Plans adopted in 2003, one on Higher and Technical Education (2003-2018); and the second on Science and Technology (2003-2018).

The latter Sub-Master Plans were formally launched in October 2003. The development of HEDP is geared towards making these two plans operational. HEDP also takes into consideration regional and international conventions and protocols on education of which Tanzania is a signatory. The implementation of HEDP is also a logical follow-up of the ESDP and the SEDP.

The primary goal of HEDP is to make a positive contribution towards the achievement of goals stipulated in Vision 2025, MKUKUTA and MKUZA (for Zanzibar), and the Millennium Development Goals. The interventions initially envisaged are to be applied in the period 2010 to 2015. The main goal of the HEDP is expected to be achieved through three developmental objectives:

- Establish a comprehensive and coordinated higher education system through undertaking institutional reforms

- Improve delivery of higher education through enhancement of relevance and diversification of curriculum, increased access, equity and quality.

- Enhance capacity of the higher education system so as to maintain and sustain all its functions effectively and efficiently.

Total budget requirement for the Programme specific activities and coordination over a five year period is TAS 490,621 million (USD 371.80 million). The largest share of the budget, about 96 percent has been committed to the critical activities under service delivery (see below). These activities include improvement of academic infrastructure, staff training, new programmes, increased enrolment and innovative ways of financing higher education.

This program is meant to cover Universities and University Colleges accredited by the Tanzania Commission for Universities (TCU) and higher education service agencies. For non-university higher education institutions accredited by the National Council for Technical

Education (NACTE), there is another Program being developed, the *Technical and Vocational Training Development Program.* For the purpose of HEDP higher education refers to the education offered by institutions registered by TCU and does not include education offered by institutions that are registered under NACTE.

Although private universities will not directly get subventions from the Government budget, they should benefit from the program as well. Private universities will be able to train their staff in well equipped and staffed public universities, recruit staff trained in public universities, continue to get students and infrastructure development loans and be connected to the National Education and Research Network. They will also indirectly benefit from other government interventions such as tax relief on education materials.

The HEDP will be implemented in two phases. Annex 4 shows the envisaged activities corresponding to the first phase to be carried out in the period 2010 – 2015. The second phase is planned to be implemented from 2015 to 2020. This will be a logical follow up of activities undertaken in phase one, in that it will primarily focus on consolidation and expansion of strategic areas. Key activities during this period will include:

- Establishment of communities of excellence and provision of equipment
- Establishment of ICT parks
- Establishment of demonstration centres
- Establishment of innovation centres
- Establishment of virtual education system

Chapter 5

Conclusions and Recommendations

5.1. General Conclusions

Tanzania, as all developing countries, faces significant internal and external challenges in the new global economy that affect not only the shape and mode of operation but also the purpose of their science, technology and innovation and higher education systems. Among the most critical dimensions of change are the convergent impacts of globalisation, the increasing importance of knowledge as the main driver of growth and the information and communications revolution.

In order that Tanzania participates more fully in the knowledge economy, an important set of initiatives have been proposed to overcome present limitations and to take advantage of existing opportunities (see f.e. Utz, 2006), among those directly relevant to this Review are to improve the overall investment climate, lift the barriers in human resources and the labour market and proactively disseminate the research and analysis performed in academic institutions to government and non government stakeholders. It has also been suggested to strengthen the governance and administration of the country's public universities, in terms of financial sustainability, up-to-date content and teacher training and use the potential of distance education to expand access to education services while at the same time improve equity.

STI and higher education are in fact the crucial factors for creating and maintaining sustainable growth. The existing long term poverty reduction goals and other national objectives can only be achieved if the focus on capacity building of STI and higher education is enhanced. A key understanding of the performance of HEI in STI comes from the fact that economic growth is increasingly tied to the supply of individuals with advanced research based education in S&T and with ample experience in research.

In spite of large efforts made by Government and donors in science and technology development, these have yet to make an important impact (with some exceptions) to a change of economic and social conditions. Recent economic growth has been brought about mainly by favourable external conditions, while at the same time there is persistent underdevelopment and poverty conditions, indicating that the country will have much difficulties in attaining the Millennium Development Goals by 2015.

It may be said at the onset that the STI system is still very weak and fragmented and that HEI although being an important element in the system, underperforms and is isolated from the other system's elements and functions. Under such situation it is also difficult to visualize the vision set to change the country's productive status into a semi industrialized country by 2025.

The performance of HEI in STI can be best characterized by an environment where there exists policy instruments related to the development and finance of the traditional tasks of HEI, training, research and extension, but that there is also indifference to research in the institutional context as well as resistance to changes in the institutional culture. Further, decision making over STI is in hands of a few adequate organizations.

The above can be attributed to a weak recognition of research in the normative architecture, which has a strong administrative bias, and the still limited existence of funding, human resources and equipment. Only more recently there is better motivation of the research community and lines of research are being drawn based on national priorities. The weak recognition of research and extension produces discrimination or lack of incentives for active researchers, which are few in number and many are self-made.

The country faces one of its greatest challenges in delivering quality higher education and improving the performance of HEI in STI, particularly research and diffusion of research results, considering the needs of the social and productive sectors, business, security etc. HEI must objectively show the productive sector that it gains in productivity and competitiveness value added and markets when cooperating with the university and using its research results. However, if HEI do not execute quality research and diffuses its results properly there will be no demand for its services. Moreover, HEI must become the leading institutions to push new ideas, visions, into society. They must become leaders of social and economic change and development

As can be drawn from the more detailed analyses that follows, all HEI and STI stakeholders in Tanzania agree that it is necessary to increase the number and the quality of the human resources, both in the public and private sectors; it is necessary to increase the public budget destined to the HEI, and it is necessary to increase the infrastructure capacities of HEI. These three large and fundamental needs represent the base on which it is possible to improve and enhance the performance of HEI in STI. It is a political decision that will support any other actions that can take place.

The main recommendation that this Review can make, following the analysis of the situation, the examination of policy and strategic documents, in particular the latest Science, Technology and Innovation Policy (under review) and the Higher Education Development Strategy, is that Tanzania requires a Roadmap which is realistic and clearly recognizes what can really be done in the short and long-terms. Extensive and overoptimistic lists of objectives and goals, in overlapping policies, weak coordination mechanisms, little funding, a disarticulated STI system, weaknesses in human resources and other limitations, cannot lead the country into an effective capacity building process of its HEI and STI systems.

The HEDP in particular, contains a very large (comprehensive and important) set of policies and strategies, as discussed in Chapter 4 /[9]. However, what will really make HEDP, STI Policy and the MCST Master Plan operative will be realism; these grand plans and strategies are not geared towards the day-to-day realities of the country. Thus HEDP, as a valuable development instrument, should be taken as a long-term policy guideline. Some of the more relevant issues contained in HEDP needed to define a simple and realistic Roadmap are brought forward to the conclusions that follow.

It should be noted that several of the recommendations, many of which require more specificity, that accompany each conclusion, are meant to guide future actions, as it would be impossible to implement all under a single Roadmap in a short or even mid-term.

/[9] A situation that also exist in the MCST Master Plan

Based on the existing extensive literature produced by both local and foreign scholars and institutions, the scooping mission conducted in Dar es Salaam in the month of September, personal consultations with key stakeholders, and the responses received to a limited survey on the situation of HEI in STI, the following conclusions and recommendations can be advanced:

5.2. The National Policy and Planning Context

1. National Development Planning	
Findings / Conclusions	**Recommendations**
• There exists an ample consensus on the need to generate economic growth that contributes to sustainable development, under sound economic policies, strengthening of the processes of social cohesion and with a strategic vision and with institutional capacities.	
• It is unclear how far the National Planning Commission has actually the power to define and above all enforce the application of established national development plans	• Government must decide whether to have an efficient and top level think tank and/or a power entitled organization. The improvement of the policy and planning context will directly impact STI and higher education policies
• There are limitations in the capacity of the Commission to undertake the task of "planning" • There are also limitations in the capacity if the Commission for monitoring – following-up the established plans and introduce corrections when needed	• Necessary to train a larger number of staff in the areas of public policy and development planning • Necessary to develop "risk assessment" and "risk governance" capacities • Develop foresight capacities as a participatory process that provides valuable inputs into the planning process and use the results of foresight exercises in developing policies • It is necessary to develop and build capacities in anticipatory mechanisms • HEI can be pivotal in supporting the tasks of the Commission and the implementation of the above recommendations, through studies and the training... • The country requires knowledge-based decision making processes. Scientifically informed decisions are key to improve governance.
• STI policies are set to solve social and economic problems and HEIs are set to promote STI including the social sciences. It is considered that present STI policies and strategies and higher education policies and strategies are yet to be better defined in national development plans, that is, STI plans need to be better embedded into national development plans	• Closer work must be undertaken between planers of social and economic development and planners of science, technology and innovation, for this to occur, governance of STI must be strengthened, as suggest below. • Development plans should consider that it is possible to combine a resource-based development approach combined with a new technology development approach, and that the STI system is pivotal for the undertakings in

	both approaches.

5.3. The Science, Technology and Innovation System

2. Governance of STI	
Findings / Conclusions	**Recommendations**
• The Ministry of Communications, Science and Technology sets policy and oversees STI organizations which are more powerful that itself. Further, sector R&D policies are defined by sector ministries, and each sector administers their R&D organizations, the question is then, what does the MCST actually administers?	• The Ministry must be empowered to run the STI system. It has been suggested the creation of a specific ministry, which would be a first step in the right direction. • Such ministry should oversee and coordinate STI focal units within each Ministry • A high level Presidential committee should oversee an overhaul of the STI governance system • The Ministry should create a think-tank to guide and advice on the development and implementation of the national STI agenda. HEI are privileged organizations to fulfil this task
• The National Plan for Science and Technology of 1999 is now under revision and there exists a draft, which has yet to be considered in the political level for adoption	• It may be important to wait for the OECD review which should take place in early 2011 before the Plan is adopted.
• The National research policy has been adopted in April 2010 • Pending further analysis, the R&D policy is too ample and ambitious to be implemented in the short or medium term. It contains excessive details, but at the same time it does not point out how several objectives and goals will be reached. It simply calls for new norms, mechanisms, institutions to be put in place.	• It would seem of little use to have both a STI Policy and Plan and a R&D Policy and Plan. Further there is also the MCST Master Plan and COSTECH Plan. These should be brought under a single framework • The R&D policy and plan (or better the single framework) should be revised under a systemic view (approach) and become a guideline, establishing a set of useful instruments, instead of setting up an excessive number of objectives, goals, mechanisms to be created • A single plan should put in place a framework to plan, coordinate, regulate, monitor, evaluate and demand accountability for STI performance
• There are institutions such as the Tanzanian Academy of Sciences which can be part of the governance mechanism, along with its more traditional academic roles, as it holds an important number of key stakeholders of the R&D system	• The Academy must receive support from government but at the same time must internally be capable of defining its organizational structure, mission and objectives to fit such governance role
• There is development of policy visions in special sectors, for example, nuclear energy policy or new and transforming technologies	• The development of new sectors must be carefully measured as in many cases there is no supporting infrastructure. • In any case, it must be considered that HEI are key instruments for any development and mechanisms must be developed to ensure the participation of universities in some

	decision making processes...
• HEI must participate fully in the definition of STI policy	• HEI should conform a special committee for policy under the joint supervision of the Ministry of Education and the Ministry of Communication, Science and Technology
	• In STI policy definitions and planning It is necessary to develop and deepen participatory approaches because as the poor do not automatically participate and benefit from STI processes.
	• The STI policy must better define the role and operational status of Public Research Organizations, considering that these can make important contributions to STI and social and economic development

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3. STI Indicators	
Findings / Conclusions	**Recommendations**
• Planning is based on statistics, and there is installed capacity for collecting economic and social indicators in the National Planning Commission. This is not the situation with STI indicators • There is an evident absence of measuring tools which are indispensable to the programming, monitoring and identification of needs. It is not possible to define STI policies without indicators; this is a fundamental issue that needs to be pursued in the future to use resources in an efficient and effective way.	• Necessary to develop capacity to collect STI indicators by the statistics office in close cooperation with COSTECH and the Ministry of Communication, Science and Technology • It is necessary to measure the existing capacity of the national statistics office (for producing and maintain STI indicators, data bases, capacity of data mining).
• Innovation surveys have been suggested by Diyamett and Wangte (2001) /[10] to develop appropriate indicators, such surveys could cover two key economic sectors, agriculture and manufacture. • UNESCO is working in the development of indicators and hopes that funds will be available to support the development of proper S&T indicators for Tanzania. Efforts would also be put to get COSTECH to fund it through the new funds from Government.	• Tanzania must first make an effort to develop science, technology activities and research indicators in the first place. These are difficult to obtain at present and those that exist are still unreliable. The UNESCO effort must be supported by Government • In time, it will be necessary to conduct comprehensive, nationwide innovation and research surveys to establish concrete factors that either facilitate or hinder innovative activities. The outcome of surveys can help put in place concrete innovation policies and strategies.

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4. The private – productive sector as element of the STI system

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/[10] Diyamett, B. and S. Wangwe (2001) Measuring Innovation in OECD and Non-OECD Countries (www.hsrcpress.ac.za)

Findings / Conclusions	Recommendation
• The Tanzanian Chamber of Commerce, Industry and Agriculture, has set up successful partnerships with Government, which has recognized that a solid well functioning private sector is key to development.	• The Chamber needs to define new goals that will be acceptable to government, in particular the definition of measures that will allow improvements in the business environment and further investment. • Investments, either local or foreign will increase to the extent that firms can find high level human resources, well trained and versed in the productive sector problems.
• The Chamber has successfully developed an extended network of affiliated units (over 100) in regions and districts. • The productive sector takes part actively in the development of the national system of STI, but not yet to the appropriate degree.	• The network can be utilized by HEI for technology information and transfer processes, as well as for marketing their services • Further incentives are need to promote the participation of the private productive sector in the build up of STI capacities
• In a joint effort with the College of Engineering of the University of Dar es Salaam, the cluster development program is becoming successful. There are already several clusters that are operational (oils, rice, cassava, mushrooms and "heritage")	• The clusters should be opened to other HEI and these must market their services within the cluster • Clusters should become active elements of the STI system and STI policy must provide support for their operation • Policy should also recognize the need to develop sector innovation systems as important complements to clustering
• National and university laboratories need to be accredited if they are to serve local and export markets	• The national conformity system must make special efforts to accredit service laboratories
• Although there are high level (e.g. PhD) personnel in HEI, there is an evident lack of technical personnel that can perform simpler tasks in the productive sector	• It is necessary to revamp technical and vocational schools, under the guidance of private sector firms • HEI should review and determine policies to train human resources in short (2 or 3 years) periods, providing technical tools to graduates.
• Lack of a maintenance culture affects productivity gains. The lack of such culture will be particularly felt in the process of mechanization of the rural areas.	• HEI can strongly contribute to improve the situation, through extensive campaigns among their students and graduates.

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5. Research and Innovation	
Findings / Conclusions	**Recommendations**
• Research is conducted by a large set of institutions, many of them belonging to the higher education system	• Strengthen institutions such as COSTECH, VETA, IPI (UDSM). Although these institutions have been created to support research and innovation, they are weakly linked to the productive sector, mainly because of the lack of financial and other technical resources need to reinforce their capacities.
• Research activities are limited due to small funding and also limitations in human resources and infrastructure	• The granting system which is emerging must consider these limitations but cannot solely be utilized in them, it is necessary to define criteria for the distribution of budget within a grant

• It is difficult to fully identify the contribution that Tanzanian scientists are making to the pool of knowledge and thus confirm the existing indicator that places Tanzania in second place after South Africa in scientific publications per capita	• COSTECH must work on bibliometric analyses • COSTECH must develop general guidelines for securing quality in local journals
• COSTECH manages data bases and facilitates access to on-line journals	• This is a practice that must continue and be enhanced • Local publications should also be encouraged to give allowance for in-country knowledge building.
• There exist established incubators and clusters in productive priority sectors.	• HEI must cooperate with these, through specifically designed plans. Universities must join forces with public and private institutions o create science parks or incubators, HEI cannot do the job alone and later interest future tenants, the joint effort must be from the onset.
• R&D management is still weak in spite of experienced improvements	• R&D organizations must be run by trained personnel in management techniques, it is not sufficient to have an able scientist as manager. Technology management requires to be extensively diffused. There is a need to professionalize R&D managers
• Innovation, including minor adaptations, should be considered the leading driver of development, which is not the case by now	• In order to have an innovation-led development, it is necessary to promote entrepreneurship and support technical and business related skills development by expanding opportunities for technical and managerial training. Such promotion includes strengthening primary, secondary, vocational, and tertiary education. In particular S&T at the university and polytechnic levels should be strengthened in order to improve the quality and quantity of human resources.
• There are minor innovations produced by R&D centres or enterprises which are not known.	• Disseminate efforts of local innovations efforts and continue promoting indigenous knowledge initiatives while tapping into the growing stock of global knowledge and attract more and diversified resources of FDI • In order to improve the commercialization of existing technologies developed by a score of institutions, and in order to avoid duplication of efforts by individual organizations in commercializing their technologies, it is suggested that some mechanism at country level is created, under the concept of a "National Innovation Centre"
• Partnerships are emerging in various forms as sources of innovation. Public - private partnerships are promising because they tie research to the needs of users, provide opportunities for improved efficiency and cost effectiveness, and augment investments by enhancing the impact of research results.	• A governance structure that assembles representatives of different stakeholders to set research priorities through appropriate forms of consultations and negotiation is likely to have the best chance of success. The development framework in which these partnerships operate should promote participation, consultation, and development that is sustainable, equitable, and inclusive. • There is an urgent need for strong strategic partnership and collaboration between the Government, research institutions, the private sector and among various stakeholders at national, regional and international levels including the

	Diaspora. As a result, the country will benefit from critical opportunities, such as capacity building in terms of human resources and facilities; rational utilization of resources; and transfer of knowledge, technology and materials.

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6. Research and Innovation in key economic and social sectors	
Findings / Conclusions	**Recommendations**
Health	
• Tanzania's medical R&D is relevant and timely as it addresses issues of national importance. Medical research focuses on endemic diseases that affect rural areas, where up to 80% of the population earn their living. Malaria is the most prevalent and serious vector-borne disease. More work has been done on malaria than any other disease. • Relevance is achieved because the main owner of R&D activity is also the formulator of health policy, and the major diseases are location specific. • The effectiveness of medical R&D is reduced by poor communication. As a result, information does not reaching the beneficiaries in a way that is effective in solving problems. Additional effort is needed to involve stakeholders and better inform them of research results.	• Policy must address some standing and limiting issues, as discussed further, human resources and infrastructure
• One example of successful research is that of Mhumbili University, in the areas of HIV and malaria, which have led to the adoption of national agendas on these two diseases. The University has appropriate laboratories for medical and drug related analyses and has participated and followed the national debates and experiences in the development of traditional medicine. Three patents on traditional product are known to have been obtained, but are not yet being fully exploited	• Research capacity can be enhanced at Mhumbili University and it should be done in coordination with the national research system • COSTECH future R&D and infrastructure support calls should also include the health sector • The STI system must accommodate the development of traditional medicine through a specific agenda by which it becomes more scientific, provides better services and develops standardized and certified products • Partnerships must be sought with foreign enterprises and / or research organization to license the patents and mass produce existing products
• There is a serious human resource shortage in the health system, it is estimated that the present work force only covers 30% of the national demand • Overtime, the health infrastructure has also deteriorated	• HEI, in particular Mhumbili University must expand its capacities, by receiving larger budget, thus improving its intake capabilities • Foreign teaching staff may be necessary for a long period of time to overcome existing shortage • The presence of new medical and health schools in different

	universities must not be discouraged and Mhumbili University could be taken as a benchmark

Industry

• Present industrial policy is delinked with higher education policy and it does not explicitly mention innovation as a goal • There are weak links between research centres and the productive sector. This can be explained by highly centralized research activities and the absence of systematic involvement of industries and other target groups in the design and implementation of the R&D activities undertaken by these institutions	• Industrial policy must be set in coordination with stakeholders in the STI system • STI policy must be set in coordination with stakeholders in the industrial system
• Industrial R&D is resource-starved. Although the potential exists for R&D institutes to contribute to the national goal of competitive and sustainable industrial development, the decline in the flow of public resources makes it difficult to achieve this objective.	• The National Fund for S&T must contemplate grants destined to industrial research under special arrangements with industry, which can be defined after the experience in several developing countries
• There is no evidence of privately funded industrial research, except for occasional consultancies and other commissioned work. Problem solving in industries is accomplished through routine maintenance and to some extent consultancies with R&D institutes, and science and engineering departments of universities and technical colleges.	• HEI and in general research centres must draw a strategy for approximation to industry, and internally improve their research outputs
• It must be recognized that industrial innovation depends on aligning the flow of knowledge to knowledge-supply chains aimed at enhancing customer-service	• Industry and R&D institutions must form key links in those chains. The practice should be a focus on demand-driven research and on encouraging researcher interaction with economic situations and problem-solving alternatives. For this to occur there is need to strengthen partnership between government, R&D institutions and the private sector (industry) in the development of joint research and development programs

Agriculture

• There are extensive efforts in R&D in the agricultural sector conducted by both public and private organizations. • R&D projects have had minimal impacts on agriculture, which is dominated by many smallholder farmers, especially those producing food crops. This group was concerned for example that new varieties did not satisfy consumer preferences and although productivity had increased, failure	• R&D policy definition for this sector must be a joint effort between Government, HEI, farmers and other stakeholders

in the market led to discontinuation of these new varieties.	
• There is a mismatch between supply of HEI and the demand in the agricultural sector which is very profound. HEI institutions serving the sector are not graduating appropriate human resources. The latter are looking for "white collar" jobs.	• HEI must revamp their programs for graduating professionals in the agricultural field. • Extension services need to be revamped with the support of HEI • HEI serving the agricultural sector, together with national and local governments must define a joint "road map" to train and use graduates in the rural areas, including the definition of extension practices, the diffusion of best practices among farmers, and several other knowledge diffusion processes, led by universities • In the rural environment, farmers should come together in order to create their productive associations, and then initiate a process of creating "collective trademarks", "collective certificates of origin", receive support (from HEI) on marketing, quality assurance and others, to overcome existing bottlenecks for the introduction of their products into the local and export markets. There are already interesting international experiences on this type of "collective" entrepreneurship (e.g. Mexico).
Social and Economic Research	
• Social research has been conducted by several private and university based institutions, carrying our traditional research, particularly in the economic field.	• These institutions need to receive financial support and must become internationally known. A strategy for diffusion of their work is needed
• The ESRF is one prestigious private research institution, with the normal limitations of funding of such organizations. It is opening a new research area on "evidence based policy development"	• Organizations such as the ESRF must continue involved in world networks, and should become closer to the universities, particularly to conduct joint research activities and co share training courses
• New skills are needed for undertaking STI policy research	• Attempts must be made to expand research activities into STI policy and social science research institutions should become the long thought think tanks for support of policy making • Research on regional economic integration should be expanded into considering STI integration. • New training activities can be offered by HEI in such new areas.

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7. Funding of the STI system	
Findings / Conclusions	**Recommendation / Main goal (s)**
• The Government STI strategy under revision, proposes to "allocate not less than 1 percent of the GDP annually for STI	• The research fund must not be a one-time fund, it is absolutely necessary that there is continuity in funding and

growing to 3 percent by 2025 in order to cater for education and training at all levels, research, development and innovation" • For the first time COSTECH has received a large research fund (around 20 million US$) representing 0.1% of GDP. To implement the fund, COSTECH made in 2009 a first call for projects, which was responded by 107 proposals, out of which 9 were accepted for a grant.	in time increase in the level of funding. • The 1% goal is appropriate and should be reached as soon as possible. This is a political decision • It is necessary to produce indicators to be able to measure the effectiveness of the funds, for example number of publications in indexed journals, patents, partnerships with industry, transfer of technology contracts, network established, and for forth • The mechanisms for providing funds to the projects that received the grants must be flexible and fast, otherwise researchers become frustrated when they receive funds late, as they might have already made commitments at the national or international level
• It is expected that the research activities of government laboratories and universities will be financed by Government special funds, the first being already run by COSTECH	• This seems an appropriate situation, but Government must assure that research funds exist on a regular bases and they increased in time • It is important that the fund would also be used to support: primary & secondary science development; supporting universities to also be grounds for research into science education; promoting the expert roles of the Academies in driving the national STI Agenda and serving as advocates for STI in the universities and outside; strengthening University-Industry linkages
• A second call for projects has already been published • At present research funds are concentrated in the implementation of Mkukuta or Kwanza, emphasizing agriculture and related sciences, leaving little funding for engineering developments	• The call emphasizes the agricultural sector, but could be opened further in the next round • COSTECH requires increasing capacities for administering the research funds.
• A research agenda is being prepared to guide future projects to be financed under the new funding. It is unclear what is the process being taken to prepare the Agenda, it seems to be an internal task of COSTECH	• Research must be prioritized in relation to its potential impact on social, economic, environmental demands. As noted above, grants in the future must also be open to technology transfer activities of those technologies that already exist in R&D institutions. • The Agenda should be set through a national S&T Coordination mechanism that is inter-ministerial and probably led from either the PMO or President's Office with MCST as Secretariat. Any other configuration can be used as long as it is inter-Ministerial in nature.
• Government is the major source of support. Nearly all R&D institutions are government-owned and operated, the outcomes are public goods, and the main beneficiary is the government. The restructuring and reforms of the 1980s and 1990s had little impact, except for the reduced inflow of public resources.	• Government must continue to be the major source and funding cannot rely on donor's funding. The private sector must invest and some technology research centres should be if not self-sufficient, at least supported in part by fees charged to its clients. • In general it is necessary to define new financial schemes for innovation, including loans, risk capital, tax exemptions, grants and others. These schemes can be combined with

• Donors provide up to 80% of funds for research. This is the most disturbing aspect of R&D in Tanzania. Only recently has the government started to provide more resources.	other instruments already in place, as science parks or incubators. Such financial schemes will create , together with other instruments, a conducive environment for new business start-ups The challenges of funding R&D activities include: • The need to increase the allocation of public funding to research in priority sectors (agriculture and health) while recognizing the role of industry in enhancing value added in agriculture and increasing productivity in the economy. This sector prioritization should be reflected in the allocation of public resources to R&D activities. • The need to give greater attention to the continuity and predictability of funding R&D activities. Fluctuations in resource allocation from year to year are not consistent with continuity in research. There is a need to improve the predictability of resource allocation. • The need to counterbalance donor domination in financing R&D activities and in influencing the research agenda by enhanced domestic ownership of the research agenda that reflects national development priorities. • The need to achieve efficiency and effectiveness in resource management and utilization through effective monitoring of research outputs and dissemination of results to achieve value for money invested in research. The steps that are being taken to improve public financial management and priority setting in budgeting are encouraging.
• The HEDP defines that research funds will mainly come directly from COSTECH through the MCST during the program • This decision simply transfers the responsibility of funding to another Ministry, "hoping" it will respond.	• The Universities should set up their own R&D budgets
• The private sector is emerging as a source of expertise and financing to supplement public sources. However, private-sector participation had tended to be concentrated on a few export crops such as tea and coffee. However, even privatized R&D activities are supplemented by public resources in two ways: first, they draw from human resources in the public sector, such as the research and extension system and second, they benefit from public resources in the form of donor funding.	• These experiences suggest that successful private-sector R&D requires public support, including complementary, strong, publicly supported research.

• Different analyses (f.e. Kahyarara, 2003) /[11] point out to the absolute need to increase funding in higher education, but that attention needs to be paid into the vocational stream, as a way to promote longer participation in the academic path and increasing returns for investment.	• A special fund for higher education is forthcoming • It needs to be noted that the financial sustainability of higher education has been extensively discussed, particularly by World Bank studies, pointing out to several difficulties that need to be overcome

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5.4. Higher Education Institutions in STI

8. HEI Governance	
Findings / Conclusions	**Recommendations**
• The Directorate of Higher Education changed in 2008 from the Ministry of Higher Education, Science and Technology to the Ministry of Education. • Such change has the merit that the Ministry has a more holistic view of the whole educational system and in that framework can better define unified policies and strategies. • The main problem with such change is that the Ministry has as its main targets primary and secondary education and higher education risks to be placed into a secondary position. • Also, due to traditional difficulties in coordination make complex the necessary linkages that must exist between the higher education sector with other actors of the national science, technology and innovation system of which universities are key actors.	• Independent of institutional changes, changes in policy definition must be avoided in order to provide continuity. • Policies need to be coordinated, thus the National S&T policy, COSTECH strategy and other S&T policies and strategies and the Higher Education Development Plan must be able to complement each other better than at present formulated. • In order to assure the necessary coordination that must exist between HEI and MCST and S&T institutions, it is important to consider the existence of a high level (Cabinet) Coordinating Inter-ministerial Committee for STI, involving the Ministry of Education and other relevant ministries that could be presided by the Minister of Communications, Science and Technology, as the leading institution of the STI system. • Internally in the Ministry of Education, the Directorate must increase its internal capacities, in particular to deal with the coordination mechanisms with other actors of the STI system.
• Higher Education receives 60% to 65% of the total budget allocated to education (approximately 600 billion TZS), of which around 50% goes into the Higher Education Student Loan Board • In order to attract students into higher education, and in particular science and technology, there needs to be policy changes, as loans are not sufficient as the promotional mechanism. • Further, it must be borne in mind that	• HEI budget must be kept high, as these institutions are the fundamental base of the STI system, and the main contributors to an advanced knowledge-based society, as advocated in the country's development vision and plans. • There are many benefits that accrue from strong HEI, one of which is the improved environment that can be created to increase research activities or attract foreign direct investment. This alone justifies higher investment in HEI. • There are many voices that argue against this recommendation in the face of the situation in the quality of primary (and secondary) education in Tanzania. But the

/[11] Kahyarara, G. MLPG 2, University of Dar es Salaam (kahyarara@udsm.ac.tz)

already some institutions, such as universities, do make large investments in the training of students, but who after graduation leave the science fields to other fields. • Any investment in science students will have a high return, as the country is short of researchers working in both the public and private sectors.	solution is not to cut HEI expenditures as is often done, but rather increase whole educational budget to fit non HEI level needs.
• The recovery of student loans is a problem the Ministry is fully aware of, requiring a solution. The repayment now stands at 12% of the total according to the World Bank Staff in the Innovation and Technology Thematic group. • The issue of the HE Student Loans is being considered in the HEDP and through other processes and actions to improve the mechanisms will be partly financed under the present World Bank project on education.	• The new mechanisms to be put in place for improving the recovery process must insure that students in the science and engineering areas conclude their studies and later remain employed for a number of years. Thus the mechanism could include the possibility of non – monetary repayments in special cases.
• The Higher Education Development Programme represents an important instrument for improving this education area. • The World Bank Project under execution is a key support instrument for the identified activities of the HEDP. • There are several issues that are not considered fully in existing projects and proposals, such as sustainability of laboratories once equipped; continuous training programs for laboratory technicians. What backward linkages and value creation can be brought in to encourage companies to be created to cater for laboratory equipment maintenance and also manufacture?	• The Higher Education Development Programme could be reviewed and enriched by the findings and suggestion of this Review. • UNESCO must closely follow the activities and results of the World Bank Project, which should become an active (although temporary) actor in the STI system • The Project should include suggestions as to measures for the retention of staff, for example by increasing level of funding of S&T activities.
• The existing Tanzanian regulatory framework for higher and vocational education is satisfactory and addressed to improve excellence in education • What is missing is an effective enforcement of regulations. This for example explains the difficulties in the recovery of student loans.	• Agencies in charge of the administration of regulations need to be strengthened with human and capital resources. • The regulatory framework must be made transparent to all stakeholders, so that the improvement of excellence in higher education can be followed by society by means of social control mechanisms
• TCU and NACTE are two key regulatory organizations. From the point of view of the performance of HEI in STI, the tasks of	• HEI require some autonomy to respond faster to existing demands of the STI system. To do this they must have initiative and flexibility. TCU and NACTE regulations must

these two organizations are central to improving linkages between HEI and other actors in the STI system.	adjust to the need of autonomy, flexibility and creativity in HEI. • Under this framework, the challenge of the HEI administration is to define the legal framework, adequate procedures and incentive systems that will stimulate entrepreneurship, while at the same time recognizing the complementary roles of university and industry.
• The Commission correctly recognizes three challenges to higher education: 1) too few universities, and as a consequence many candidates are turned down; 2) Few students interested in S&T; 3) Spatial distribution is skewed, some regions do not have HEI	• S&T promotion at the secondary level is important and in fact the HEI strategic plan emphasizes and prioritizes science and technology. Further promotion under structured programs must be put in place, not only to increase number of interested students but also to improve the level and quality of science teaching at the primary and secondary levels.
• The Commission recognizes several opportunities to advance an S&T agenda: 1) free movement of labour inside the East African Community; 2) increasing number of exchange programs; 3) Ease of access to Internet; 4) Government has a positive attitude towards S&T	• Attitude is not enough, the challenge is not commitment but rather to improve the structure on which S&T must be built

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9. Access to Universities and Infrastructure	
Findings / Conclusions	**Recommendations**
• From early available data, the Secondary Education Development Programme is contributing to improve the quality of future entrants to higher education. A full impact of the Programme cannot be measured as yet but trends are positive.	• Continue monitoring and evaluation the SEDP so that adjustments can be made when necessary.
• The admissions system for all universities, public or private is now centralized (it has been applicable for the first time in the academic year 2010/2011) thus facilitating the work of the individual universities of qualifying individuals and being subject to undue pressures	• This practice can be kept, but in time, as the system grows, some responsibility will need to be transferred to the universities
• Students who access the universities show several weaknesses in their basic preparation and attitudes. They lack creativity and innovativeness, thus affecting their future behaviour as professionals and entrepreneurs. • The use of ICT, although growing in the past years, is still at its early stages among young students. ICT knowledge is an indispensable tool for students who seek entrance to HEI	• The review of the secondary (and primary) education curricula must be a permanent exercise to continually adjust to national and local demands. • There are ways that have been used to improve creativity and innovativeness in students who seek higher education, for example the use of science fairs, the creation of science clubs, scientific camps and others that must be enhanced. • At entry, provide a "compulsory" English language course of one semester duration • The execution of an extended ICT development programme

• The lack of knowledge of the English language (used for teaching in the HE system), is a major drawback for entry and permanence. This situation affects in particular students from the rural areas.	among young students is a key priority
• The TCU has established lower entry points to allow a larger number of candidates to access these HEI. The resulting massification generally (but not necessarily) results in lower quality, but does in effect provide a way for allowing students coming from different social and economic levels, and thus differently qualified to access HE. • The above does not contradict the fact that there are too few universities to receive all entrants with equal opportunity of access.	• Once students are admitted they must adhere to strict academic standards, while at the same time HEI provide remedial measures to even-up differences that may exist in preparation at the secondary level and thus provide potentially able students with better opportunity to conclude their HE training. • There should also be an improvement of gender gaps that still exist. • New HEI are necessary but at the same time care must be given to authorize any HEI of doubtful quality.
• There are some universities and different units within them that have adequate laboratories and other facilities, but in general there the infrastructure is weak to receive all potential students. • The R&D infrastructure is still underdeveloped, as well as research equipment is obsolete in several areas. The lack of infrastructure and in some cases adequately trained personnel does not allow training of the best quality.	• This is a problem of lack of funding which should be considered as a priority • TCU and NACTE must develop quality assurance standards for HEI laboratories

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10. Academic Staff	
Findings / Conclusions	**Recommendations**
• HEI face several challenges when dealing with the issue of academic staff. Some of the key limitations can be described as follows. • There is a limited number of doctoral level staff that stems from aging and lack of more adequate salaries (although this has improved in more recent years). • A large number of staff has only the first university degree • The number of doctoral level candidates is low because this education level is only at its beginning in the country. • The numbers of doctoral level students that return from abroad often find difficulties to access vacancies in universities, resulting in brain-drain.	• Negotiate with donors procedures for promoting the return of PhD recipients • Define a promotional program to attract Tanzanian PhD holders working abroad • Define a promotional program to attract non-Tanzanian PhD holders who wish to contribute for specific periods of time • Define a doctoral program in-house and abroad, under a wide scheme. Such program cannot be only dealt with by HEI, it requires close follow up with much higher authorities than the universities. It may involve policy decisions that the Presidency might want to pronounce on as well as the Ministry of Foreign Affairs interactions through its Embassies and High Commissions. The main goals of such program will be to prepare a larger number of PhD recipients, particularly in the areas of science and engineering where the weakness is the highest.

• Employment opportunities are not large outside the university environment for high level graduates	
• An important fraction of the academic staff (~ 70%) does not normally participate in research activities	
• Poor policies and lack of promotion of innovation discourages academicians to do innovative research, only about 20% conduct R&D at present	
• In general there is lacking is a clear employment policy by HEI and government, together with R&D promotional policies and funding.	
• Academic staff in HEI is hired according to well established procedures. There is however a noted need that progress must be made in the improvement of qualifications requirements.	• It is necessary to increase the qualification of the university staff and to establish a system of monitoring and permanent evaluation.

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11. Contents of Higher Education Programs	
Findings / Conclusions	**Recommendations**
• An important fraction of the academic staff (50%) believe that even though programs take into account the demands generated by the productive sector, it is necessary to update such contents to better meet them. • HEI must equip themselves with educational programs that will lead the country into higher productivity levels.	• It is necessary to improve the orientation of the coverage of higher education by following the national development priorities, in particular agriculture, industry and services. For such purpose an analysis of academic supply – demand (by sector and labour qualifications) must be undertaken • HEI institutions should re define their programs with a 2025 vision. • It is necessary to enhance the skills level and capacity of curriculum developers. • It is necessary to reform teaching methods and the curriculum at all levels to include skills and competencies for the knowledge economy (communication, problem-solving, creativity an team working skills) and to harmonize technical education offered in secondary schools with that offered in technical colleges, and then link up with the proposed zonal and regional colleges and institutions. • Moreover it is necessary to increase the interface between industry and education and offer differentiated curricula hat better meet the new skills required by changing market and technologies • HEI can help enhance technical and business related skills development among the population using ITC and in close coordination with technical institutes and vocational centres.
• Few HEI institutions coordinate their curriculum development with other actors of	• The practices of DIT is a practice that must be kept and

the STI system. • The Dar es Salaam Institute of Technology is one of the exceptions that undertake this task through email and written consultations with other actors and validation workshops.	enhanced • All HEI should establish working agreements with the Open University to synergize their outreach programs
• Science and engineering careers have become less attractive, the number of students enrolled in them is decreasing • The above is a trend that affects most countries and is due to the fact that liberal careers have been greatly demanded by globalization and economic liberalization policies	• Revaluate the science and engineering careers by stronger promotion, joining partnerships with the private sector, providing open opportunities
• Entrepreneurship at all levels needs to be enhanced and HEI play the key role. One area that needs reforms is that of business administration which today is conducted along very traditional lines. • There is a lack of promotional policies for entrepreneurship as well as a change of mind-set by political leaders regarding this attitude.	• Define specific programs for training entrepreneurs not only for business and market but also for technology-based, environment, micro financing, social innovations • There is a need to train young people to be flexible and to acquire the capacity to adapt easily to a rapidly changing world. It is thus necessary that HEI programs facilitate the creation of: expert thinking: solving problems for which there are no rules-based solutions: complex communications; conduct routine cognitive tasks, routine and non-routine manual tasks
• Postgraduate level is offered by several universities covering master level degrees and fewer doctoral level courses. • The number of students attending postgraduate schools is relatively small when compared to the existing potential.	• HEI must enhance their capacities for delivering postgraduate education. It has already been experimented with success cooperation schemes by which a well established foreign university provides the initial inputs. The results of these experiences must be internalized, as a way of expanding this level of education. • Of course there are many other requirements for delivering high level and high quality postgraduate education. Probably a specific working group could provide all the inputs needed to define such level of higher education. • This level requires among other things, the existence of centre of excellence in research, so an effort must be pursued to create or strengthen such centres.
• Engineering programmes normally require their students a training period in industry. In many cases such training is required once after every semester of study (each for 8 weeks). This practice while important, has imposed a heavy burden on industry and especially small firms, to receive student trainees	• This practice must be kept but it may not be necessary to require training in industry once after every semester.

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12. Quality control and accreditation

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Findings / Conclusions	Recommendations
• The accreditation mechanism is in place, and although it must be revised from time to time, it is strong enough to guarantee an appropriate level of quality at present	• The existing mechanism can be strengthened, but in particular, its recommendations must be strongly enforced. Only in this way quality will actually be improved. • The university system must approach a regional / or international accreditations mechanism in order to advance to a regional / international institutional and program recognition. • There is a need to begin to work with the TCU and other necessary agencies such as the Engineering Accreditation Board to move towards a regional /international accreditation standard such as the Washington, Sydney and Dublin accord as well as moving towards the *Engineers Mobility Forum agreement*. • Although still at an early stage, Tanzania could lead a regional movement towards defining accreditation mechanisms at regional level
• There are a number of mechanisms such as the Interuniversity Council, NACXTE, TCU, and in-house processes that assure benchmarking and quality assurance mechanisms.	• It is necessary to define some form of "standards" committee by the Ministry of Education and set lines for improved benchmarking. • It is particularly important that a transparent benchmark exists especially when the university approaches the productive sector. • Collect "best practices" and working them through TCU and the universities to reach several goals, among them improvement of quality aligning universities with international standards.

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13. Research and Innovation and Services in HEI and Linkages	
Findings / Conclusions	Recommendations
• Universities differ greatly in size, strategy and "core capabilities" and in the way they participate in research, innovation and service. • The above differences influence the R&D and services activities in HEI and their linkages with other actors of the STI system and their response to national demands.	• Internal policies must be put in place to facilitate the growth of core capacities for R&D and services, according to the size and specialization of each HEI
• All HEI wish to become leaders in STI but for that to occur R&D and networking activities must be enhanced.	• HEI need to set policy objectives and goals towards developing R&D and STI related activities and setting up specific funds and also define sources of funding accompanied by adequate measures to access them
• Universities, even the larger ones, are still passive actors in the STI system, as they have been unable to respond to dynamic social and economic demands	• Internally HEI need to reverse this attitude and externally Government must define policy guidelines for converting HEI into an active player in the system. • Effort must be made by COSTECH and MCST to address

	• this issue, so as to strengthen the STI functions of HEI. • UNESCO should work to ensure that the program of the STI Reform included the HEIs.
• All universities and technical institutes have a supply side technology development vision, and within this vision have made some limited progress in developing technologies which impact social development, in particular low cost equipment and installations	• Universities must have a better overview of the market demands and commercialize its products more aggressively, in close cooperation with firms that can mass produce its existing prototypes • Universities must pursue very close ties with international and regional organizations, with whom little interaction has taken place until now
• On-going research activities, although limited, are in fact creating new products that can be commercialized as they respond to existing social demands. This Review has detected several examples, as discussed in the previous Chapter.	• The limited technology transfer that exists must be overcome by an aggressive unit of marketing, which HEI executing research do not have. Only a fully fledged structure will allow improvements in the technology transfer process. • The marketing structure seems to be more important or at least equally important as the Intellectual Property unit that already exists for example in the UDSM. • HEI must continue (and improve) identifying social, economic and environmental demands in a more structured and systematic way • There are several issues that need to be resolved to improve linkages: forward and backward linkages with the local industries and markets as well as supporting the creation of clusters, business incubators, venture capitals, and stronger awareness among stakeholders and the general populace on the availability of these research products for them to invest on.
• There are technologies developed which can significantly impact on poor areas, for example in low cost domestic electric wiring	• If such efforts are "synergized" with for example those between DIT and ARDHI University of low cost housing, then both universities would have a powerful "technology" that could be transferred and would have ample demand.
• There are several universities and technological universities, such as ARDHI (under TCU) and DIT (under NCTE), that occupy extremely important knowledge niches, which are full of opportunities.	• The "land" related activities of ARDHI need to be permanently enhanced, so as to exploit the opportunities. • The University does not need to expand (as it is already planning) into other knowledge areas (such as civil engineering or economics). Expansion can come within its own niche, for example opening branches in other regions of the country or opening new land related programs. This way of expansion will really create a centre of excellence. • Although this recommendation is directed to one university, it may be applied to several others which are considering diversification without the necessary means. • The University has recognized its potentials and must aggressively pursue the "Operational Policy and Procedures for Marketing and Public Relations" it adopted in October 2009. A strong marketing and public relations infrastructure

	needs to be built for the Policy to be implemented. • Because of the important knowledge niche it occupies, the University must adopt a research policy and agenda, and this effort can be supported from outside the University, for example by a bilateral donor or government, through the newly established research fund run by COSTECH
• R&D centres in HEI have capacity to define, prepare and present research projects to donors or to respond to public calls, both nationally and internationally. • At present, Government is the sole funder of R&D	• Practice in many developing countries have shown that a specially trained team of people for drawing project proposals is the best support to well defined projects. Such team can also support the efforts of HEI in maintaining a well organized alert system that will follow in a permanent and structured fashion national and international calls for research projects and detect potential partners for collaboration.
• Universities do not patent research results, although some have a patent office that can provide the service of patenting (UDSM)	• Monitor what has been done in the different research units and detect possible patentable inventions (or minor innovations) or other intellectual property figures • Create incentives for patenting, for example COSTECH should be involved in somehow collating efforts from research in the HEI and supporting those with viability through the grants of 1% GDP that Government provides.
• The weakest link between science and technology activities executed by HEI is found in industry, in particular the smaller manufacturing establishments, as these have little or no contact with R&D institutes. • Part of the problem is due to the fact that research activities are over-centralized and industries and other target groups have little involvement in decision-making, especially in setting priorities for research, or there is poor communication of research results to intended beneficiaries thus limiting the usefulness of research activities. • A still underdeveloped private sector cannot demand very much from HEI /[12].	• Relationships between HEI and the productive sector require a strong impulse. One way to attain this is that HEI look for demands and do not passively wait for these to appear • Universities need to become aggressive, looking for problems to solve in the productive sector. Initially at least, they should themselves determine the demand for their services and research results • A review of the objectives set in the Sustainable Industry Policy for human development and research could constitute an important exercise of HEI to find new demand

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[12] During the Validation Workshop on 15 June, 2011, it was indicated that one reason for the lack of linkages is the absence of an industrialization strategy. However, a short, medium and long term policy and strategy does exists since 1996 (Ministry of Industry, 1996)

• There is a mismatch between the supply of HEI and the demand of the productive sector (firms). • This mismatch is also present in public R&D organizations. • Much transfer is done thanks to personal contacts inside the STI system • There exist lack of efficient structures that allow the transfer of technology between HEIs and the productive sector.	• HEI must provide a very solid general knowledge base and abilities that would allow their graduates to quickly adapt to the very fast changing technology environment and social and economic needs. Flexibility is key in a rapidly changing environment. • For the above flexibility to be successful, continuous education is essential and HEI in Tanzania must develop capacities to deliver it. • While flexibility is necessary, it is also important to have highly specialized individuals, but able to change their abilities and absorb new knowledge for adapting to changes • Policy definition for a "structural" transfer of technology through established channels, such as the Technology Development and Transfer Centre or the Consultancy Bureau, are needed. This experience at the University of Dar es Salaam can serve as an example to other HEI. • One element that permits the approach between HEI and the productive sector (and the STI system) is "bridge" structures. Many countries have multiplied in the past two decades this type of structures, adapting them as a result of priorities and investing public resources in the way of incentives • The Diaspora can be used as an effective knowledge transfer instrument, but Government and private agents must define a concrete process to promote and use it effectively. A disorganized process will not go very far. • Institutionalize and support incubation, clustering and licensing for effective technology transfer, development, and commercialization
• Some universities such as UDSM participate in the work of service organizations such as the national standards committees	• A more active participation is required in all committees. This participation must continue and be increased. The NBS is an important player in the STI system and must be brought nearer the STI governance mechanisms, for example major interactions with COSTECH
• There is a precise awareness of the need of constructing a maintenance culture in the country to increase productivity. The DIT is about to offer an MS level program on maintenance management	• The efforts of creating a maintenance culture must be supported by additional extra funding and extensive campaign at all levels, schools, firms, government organizations etc
• Partnerships between the academic – productive sector and government are essential, to make HEI active players in the STI system and that requires they have a better and more realistic view of the environment in which they evolve. Policies must support overcoming existing	• An in-depth study on supply and demand of high level human resources needs to be made with some priority. This study should lead to better identify demands from government and productive sector and the supply of universities, including the adjustments that need to be made to the existing curricula.

limitations.	
• Some HEIs offer high level consultancy and other services (e.g. laboratory analyses) to Government and enterprises, but this is a practice that is far from being of a permanent and consistent character. • This practice has three positive results: it allows guiding research towards the solution of concrete problems of enterprises, permits research laboratories to obtain external resources that indirectly support fundamental research, and generates a source of financing to allow for scholarships for young researchers. • HEI laboratories are used by firms to a limited extent, in the sense that this utilization is made possible more by personal contacts than a structured mechanism.	• There are several requirements to improve opportunities for HEI, such as the need to modernize and to articulate the laboratory network of science and technology and to relate it to the certification of products and conformity evaluation of industrial and agricultural production. HEI must not duplicate laboratories and rather cooperate with each other, specializing their services • Laboratories must become specialized by specific product and for each specific product the Laboratory must be provided with a certification, first by a government authority, by a producer, by an exporter, as first steps in regional and international certification • HEI must establish policies addressed to providing services. Services would then be not only serve the needs of the demand, but also to allow students and staff to become aware of the productive sector needs, thus creating solid base for technology transfer processes.

Chapter 6

Towards a Roadmap for the Improvement of the Performance of Higher Education Institutions in STI

6.1. Platform for a Roadmap

The main objective of developing and implementing a Roadmap will be to contribute to the effort of the Tanzanian Government to transform HEI into major players of sustained development, and in particular in STI. The Roadmap will particularly seek to set the way of fully integrate HEI into the STI system, through actions destined to align HEI to international practices and to improve the financial and strategic management of the Universities´ human resources, research, technology and innovation, academic cooperation and partnerships, including the business environment and research centres. As already discussed, the Roadmap should include a limited but realistic number of objectives and activities, particularly centred around those which can effectively be undertaken under the present development conditions and capacities of the country.

This Chapter will delineate some of the main inputs that need to be considered in the definition of the Roadmap, which should be built in a participatory process with the main Tanzanian stakeholders and with the support of UNESCO and other multilateral and bilateral cooperation agencies.

In developing inputs to the Roadmap, it should be clearly noted that HEI in Tanzania can be expected to conduct its traditional tasks of training, education and research and extension, but at the same time should not be expected to conduct many of the activities involved in the innovation process, as it is sometimes expected to do. HEI cannot take on the role that the whole STI system should perform. Thus it is necessary that these institutions pursue a limited but comprehensive set of objectives, through the adoption of adequate policies, supported and guided by HEDP which should constitute the general guiding policy.

The suggested Roadmap could concentrate mainly, although not exclusively, on two of the HEI's objectives, namely research and extension, as these are the weakest today, and further because research in particular has as one objective the improvement of the quality of education and training. Other key objectives for improving the latter are well identified by present policies and contained in on-going plans and strategies.

Under the above context, the Roadmap should be constructed along a platform as follows:

- Normative framework:
    - Review of the normativity of HEI to adequate to the strengthening of the education and training and the improvement of the research and extension functions
    - Preparation of a General By-Law of research and extension characterized by simplicity, flexibility and operationally oriented

- Policy framework
    - Favour conditions to research and extension
    - Develop a strategy for mobilization

- Define the concept of academic freedom and act accordingly
- Create and strengthen human and organizational capacities
- Guidelines for research activities: identify areas of opportunity, priorities and programming
- Linkages of university research

- Organizational ad functional framework
  - Normative definitions
  - Guidance of research and extension: organization
  - The role of a research and extension office(s) in the institutional architecture and interactions
  - Operational organization: Centres and Institutes
  - Value and diffusion: linkage and transference centres

- Financial framework
  - Own resources
  - National Plan for S&T (COSTECH and National Fund)
  - Institutions and Enterprises
  - International Cooperation

6.2. The Policy Framework: Policy Objectives

The improved performance of Tanzania HEI in STI fundament the need of a science university policy with a strong and continued institutional compromise, this is, **each University** must adopt, within their mandates, and considering their limitations, a comprehensive policy that will in time develop the research and extension functions.

The policy framework will define most of the Roadmap and in order to advance in its formulation, it is important to redefine the main policy (interconnected) objectives that should be pursued by HEI, the main purpose being the creation of research (and extension) capacities for innovation and influencing a change in the institutional culture, generalizing a scientific and innovation culture. Reaching such objectives will effectively revaluate the role of the HEI as public institutions at the service of society.

The **first policy objective** is to improve the quality in the education and training of students and develop a critical mass of a well trained human resource base. From the research and extension vision, such objective will be reached when quality of research has been achieved by raising standards. An indicator to an improvement in standards will be the visibility of research, through for example increase of scientific and technological production: co-publications and co-patents. Also, the channels of diffusion of research results should be a matter of concern in policy, for example the improvement of local journals.

A **second policy objective** should be to complement existing research capacities among HEI and with those of government and other public and private institutions. Atomization must be avoided. Reaching this objective will help increase investment in infrastructure and to define more ambitious project objectives, many linked with international partners.

A **third policy objective** is to develop associative capacities in research through different forms of association, privileging the creation of national and participation in international networks, Tanzanian HEI must consider that there are networks at the institutional level (universities); teaching level (between programs and departments collaborating in teaching

and joint postgraduate courses); faculties and programs level, to mobilize personnel with academic recognition; thematic (groups of research and researchers) with multiple activities; Laboratory "without-walls" (groups of researchers and research conducting joint research projects. Policy must respond to the fact that networks are social organizations responding to specific motivations, interests and cultures.

Networks will effectively support the identification of increased research focus and increase information exchange that will reinforce private and public sector efforts for the improvements of the interconnection of education and research. They will also create new initiatives for more effective coordination and cooperation aiming at interconnecting knowledge, science and research and innovation, as well as business, entrepreneurial and research centres, leading to an improved uptake and dissemination of research results for innovation, in particular for micro and SME.

A **fourth policy objective** is related to the University's "third mission", which here has been designated as extension, but that it actually covers much more, as discussed in the conceptual framework. Such 'mission" can and should be discussed extensively among stakeholders. For this purpose it would be important to create an open research and innovation forum, as an open platform, based on the idea that in a world of distributed knowledge, enterprises and research organizations benefit mutually and learn one from each other, allowing technology transfer.

The Forum will establish a regular dialogue on STI that will consolidate cooperation between Tanzanian institutions and to update common priorities, encourage policy learning and ensure the proper implementation and effectiveness of cooperation instruments. The forum under patronage of UNESCO and MCST will be devoted to good practices, relevant to Tanzania, of technology development and innovation and will have a national and international character.

One of the key expected results of the Forum will be to improve the quality and effectiveness of scientific and technological research and provision of services through increased information exchange. It should also increased synergies between research and cooperation programs, including human resource strengthening activities. The Forum will support the future definition of more comprehensive joint strategy in research and innovation, supporting, among others, an improved use of the possibilities that ICT offers.

A **fifth policy objective** has to do with mobility and migratory flows, to understand and define actions related to brain drain, brain gain, and brain circulation. The Diaspora and foreign researchers can support the advancement of HEI in STI through quality research. The fostering of cooperation for human and institutional capacity building should encourage the return of researchers, or the participation of Tanzanian researchers in national research projects

A **sixth policy objective** is the promotion and creation of postgraduate studies, including the improvement of management. Cooperative postgraduate studies must take place as no single HEI is sufficiently strong to conduct their own courses.

A **seventh policy objective** is related to funding. The recently provided funds to COSTECH must be made permanent and increase, and these must be provide to HEOI for their research and extension activities, specially technology transfer. In this way HEI will link more effectively with the social and productive contexts and contribute to social and economic development. An increase in local funding will also improve the image of Tanzania a serious

recipient of donor contributions. Further, increase capacity of human resources will allow individual researchers and groups to access international funding and also increased FDI.

An **eighth policy objective** is related to the definition of research areas. At present, and for some time, the country cannot undertake all areas; there must be a certain degree of prioritization. Such process must take into account national development plans, but also at the same time the necessary academic freedom that must exist in HEI so that research can prosper. One such area is the boosting of new technologies and technology transfer for economic development, but with realism as to what new technologies can actually be developed or transferred successfully,

Among opportunities it is necessary to create public awareness on available indigenous knowledge and resources and their benefits. For this purpose it will be necessary to create capacity to research, document, sustainably preserve and popularize indigenous knowledge and technologies; support commercial efforts aimed at translating indigenous knowledge, resources and technologies into tangible products; register all newly established products and processes with intellectual property rights authorities: and mainstream indigenous knowledge and skills into school science curricula. Such type of effort should enable sustainable research, innovation and knowledge contribution of ancestral and traditional knowledge to development.

Finally, it is proposed that the above guidelines for a Roadmap in the Review that should inform, complement and enrich the High Education Development Strategy, be integrated with it into a single new strategy.

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Annex 1

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