

Leveraging Science, Technology and Innovation for National Development in the Light of the Emerging Universities of Science and Technology in Kenya

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Abstract

It is recognized that effective leveraging of science, technology and innovation is essential for wealth creation in all nations. Science, Technology and Innovation is also a key component of social integration, sustainable development and poverty eradication based on equity, freedom, justice, governance, peace and prosperity. At the international level, science, technology and innovation act as a tool of international co-operation and solidarity. It is useful for provision of knowledge and information as well as facilitating globalization with human development while concomitantly strengthening national governance and acting as a vector of common heritage, international cooperation and solidarity. Appropriate Science, Technology and Innovation policy is key to the production, distribution and use of knowledge and information. This paper endeavours to underscore how the continued growth of universities of science and technology could steer Kenya's economic growth among other priority areas as outlined by the government.

Key Words: Science & Technology, Education, Development, Employment, University

1. Introduction

In Sessional Paper No 14 of the year 2012, the Government of Kenya mentions that knowledge creation and application is key to Kenya's economic growth, global competitiveness and meaningful employment creation in a global context where there are significant shifts in knowledge production, accompanied by shifts in global wealth (Republic of Kenya, 2012 a). Kenya Vision 2030 recognises the critical role played by Research and Development (R&D) and Innovation in accelerating economic development in all the newly industrializing countries of the world. According to this Sessional Paper No. 14 of the year 2012, the Kenya Science, Technology and Innovation (ST&I) sector is fragmented, losing on the benefits of synergy and networking. It also lacks national research agenda and does not have a strong institutional framework. Other challenges that ST&I sector in Kenya faces include poor linkages between the researchers and industry; inadequate funding with great over-reliance on external resources; lack of advocacy for ST&I at high political and policy levels; low science culture among the population; relatively low global competitiveness ranking and weak performance management framework.

The Kenya Government formulated a policy framework in the year 2012 whose main objectives are to create endogenous ST&I capacities appropriate to national needs, priorities and resources, and to create a science, technology and innovation culture whereby solutions to socio-cultural and economic problems of the individual, the community and the nation are recognized and sought within the domain of ST&I. The policy is based on the guiding principles of relevance, realism, cost-effectiveness, multi-disciplinarily and synergy, partnerships, environmental protection and conservation, empowerment and participation, equity and non-discrimination, ethical leadership and good governance (Republic of Kenya, 2012b).

ST&I is one of the foundations for socio-economic transformation in the Kenya Vision 2030, enabling creation of new knowledge which plays a central role in wealth creation, social welfare and international competitiveness. At the economic front, science, technology and innovation plays a critical role in ensuring that productivity growth occurs, and that the economy is progressively transformed into a knowledge-based economy. Universities and research institutions are critical drivers of innovation systems and the resultant developments in ST&I and application of knowledge, especially in biotechnology, value-addition, manufacturing, Information and Communication Technologies (ICT). This leads to industrial and entrepreneurial development with new products and services, and areas of economic growth. The national sectors significant to achievement of national growth and development targets are Agriculture and Rural development; Health and Life Sciences; Trade and Industry; Human Resource Development; Physical Infrastructure; Energy; Environment and Natural Resource Management; Information Communication Technology (ICT); and Space Science Technology. The areas of innovation given a high priority are biotechnology; space science; telecommunications, electronics and computers; and automobile and nuclear electricity (Republic of Kenya, 2012b).

The Kenya government (Republic of Kenya, 2012a) mentions that an effective innovation system is required for a country to harness the potential offered by modern science and technology to its social and economic advantage. Kenya's current innovation system lacks coordination among the actors, is linear and fragmented, has limited linkages between academia, industry and government; the academic curricula and graduate skill sets are not well-aligned to industry needs and has inadequate funding and support for innovations. Generally, it does not effectively serve critical national needs. The government has therefore adopted a new Kenya national innovation system (KNIS). The system ensures that the education and research system (schools, higher learning, vocational & technical institutions, research centres), the business system (small and large scales), the intermediate organisations, ST&I infrastructure (financial, information, IPR regime, regulatory, incubation centres, science and technology parks, special economic zones, etc.) and framework conditions in which they operate interact, dynamically and effectively respond to national needs of the stakeholders (consumer, private sector and Government), while continuously learning from these interactions. It is with this in mind that this paper sets out to make an appraisal of how universities of science and technology can leverage national development in Kenya.

2. International Advocacy for Science and technology

Perhaps, the most comprehensive international advocacy underscoring the place of science and technology is the United Nations (UN) Resolution 2011/17: *Science and technology for development*. This is because it's a call made by all UN member countries, consequently being the world's decision and advocacy. In this Resolution, the UN recognizes the critical role of science, technology and innovation in building and maintaining national competitiveness in the global economy, addressing global challenges and in realizing sustainable development and the seminal role that information and communications technologies play in promoting and empowering science, technology and innovation for development. The UN resolution further recognizes that:

(...) that collaborative learning is central to innovation, technology transfer, and entrepreneurship and involves absorptive and productive capacity-building at the individual and the organizational levels (...) (United Nations' Resolution 2011/17: *Science and technology for development*.)

The United Nations Resolution on Science and technology for development takes note that open access and virtual science libraries are two complementary mechanisms to increase and extend knowledge flow and help developing countries to obtain data and research. It further notes that greater attention needs to be paid to the growing array of online scientific and technical resources relevant to scientific and technical communities worldwide. In this regard, the Resolution recognizes further that the effective introduction of ICTs in education requires not only access to technology but also to build capacities for science, technology and innovation, absorption and production through development of human resources, educational framework conditions, infrastructure and progressive national policies (United Nations' Resolution 2011/17: *Science and technology for development*.).

The UN Resolution notes that Geographic Information Systems (GIS) and geospatial analysis are used in many sectors of society and have important applications in addressing development challenges but remain under-utilized for transformational potential. It recognizes the Resolution 66/211 on Science and Technology for Development encouraged United Nations Conference on Trade and Development to continue to undertake Science, Technology and Innovation Policy (STIP) reviews, with a view to assisting developing countries and countries with economies in transition in

identifying the measures that are needed to integrate science, technology and innovation policies into their national development strategies.

Recognizing further that it is crucial to understand the means by which people of different gender, ages, socioeconomic situations, and organizations build the capabilities required to achieve greater capacities for entrepreneurship and collaborative development, the UN Decided to make the following recommendations for consideration by national Governments, the Commission on Science and Technology for Development and UNCTAD:

Government, individually and collectively are encouraged to take into account the findings of the Commission and consider taking the following actions:

(...) Promote the development of ICT platforms, involving national research institutes and universities, with a view to participating in international research networks and benefiting from the opportunities for collaborative learning (...). Ensure that multilateral governance mechanisms and standardization bodies of ICT and global networks are democratic, fair, and coherent, with effective participation of developing countries (...). Promote national policies to encourage the use of ICTs, especially those that have been tailored to local needs in their countries and establish programmes for the improvement of human resources in this field (...). Foster partnerships with other stakeholders to overcome basic infrastructural constraints, such as electricity and other services, that limit access to and use of ICT resources, with particular attention to locally adapted solutions that can be scaled up regionally (...). Collaborate to address the "content divide" by exploring ways of increasing online scientific publications and accessibility of content in local languages (...). (United Nations' Resolution 2011/17: Science and technology for development.)

Through the Resolution, the UN recommends further, that Governments, individually and collectively:

(...) Encourage national research agencies and foundations to provide data and research results to the public domain, and make them freely available in an open and accessible format (...). Encourage international collaboration in disseminating digitized publications resulting from publicly-funded research, making it freely available online and easily accessible (...). Encourage, in partnership with other stakeholders, the logistical and financial viability of virtual science libraries, particularly those that include a platform to facilitate networking among scientists across geographic boundaries and provide an integrated search capability across all available online publications; (...). Encourage the formation of national research and education networks (NRENs), which encourage networking among scientists, increase collective buying power for online science research services including access to journals, and result in sharing of scarce resources (...). Strengthen secondary and postsecondary curricula to better integrate GIS and fundamental concepts of geography that enrich spatial thinking in national education programs and by supporting teachers through training to better integrate GIS, geography and spatial thinking into their professional development (...). Establish bodies dedicated to obtaining, storing and disseminating geographic data, including remote-sensing data, to make GIS data available for public use at the lowest cost (United Nations' Resolution 2011/17: Science and technology for development.)

The Resolution further recommends that Governments, individually and collectively:

(...) Involve the private sector in the process of increasing technology openness for geo-spatial data. For example, public sector organizations such as government agencies and libraries, can collaborate with private sector firms to index geospatial information and make it easily searchable and available online (...). Promote the dissemination of successful experiences, including of constraint-based innovations, to foster an innovative culture through mechanisms such as the creation of awards and mass media campaigns (...). Encourage and support efforts of learning and capacity development at the firm and industry levels through the provision of an enabling environment. (...). Encourage scientific, research and academic institutions in their countries, especially in developed countries, to collaborate with counterparts in all other countries with particular attention to those in the least developed countries (LDCs) (...). Recognize the need to continue providing adequate funding and resources for science and technology particularly in developing countries and consider mechanisms with a view to apply a "gender lens" in scientific research, from agenda setting, to the design and implementation of projects, for example through the use of quotas and gender-sensitive assessment and evaluation (United Nations' Resolution 2011/17: Science and technology for development.)

3. Role of Science and Technology in Development

Heiba (2011), discusses that the degree of economic development stages of nations depends largely on how these nations conduct and apply technology, science and knowledge in their societies. The future development programs of a country are functions of its technology, science, knowledge and management leadership modes. The success or failure of such programs depends a great deal on the capability and ability of management leadership, its behavior and the way of thinking and future outlook. Leadership's role is responsible for building learning climate, shared vision and challenge prevailing mental task. It is also responsible for building organizations where people are continually expanding their capabilities to shape their future for desirable outcomes.

Sharma (2005), points out that scientific and technological development presents tremendous opportunities for economic growth, poverty reduction, and human development. Technology not only helps in doing old things in better ways but also demonstrates new ways of doing previously unimagined things, the technological development such as industrial revolution, green revolution, advancement in health sciences, improvement in transport technology, the fusion of information and communication technology. Progress in knowledge and education has broken the bounds of cost, time, distance and capability of doing things. These developments have helped to increase production and productivity of the economy dramatically. However, the dissemination and utilization of technological development have been uneven and the benefits of these developments have been distributed to the poorer countries, poorly. Sharma (2005), remarks that:

(...)Technology does not become useful and sustainable if it is not appropriate. However, if the technology is simple, labour intensive, applicable to small productive units, carries smaller risk, and suits the country conditions the technology will be more sustainable (...) (Sharma, 2005:3).

According to Sharma (2005), technological progress should not be confined to the industrial and mechanical arts. It should also include improvements in economic organization-perhaps a reform of marketing arrangements, or better incentives for extension workers or better management of the economy. Furthermore it covers improvements in skill, resulting from formal training or from 'learning by doing'. These types of changes can also lower average cost sometimes substantially and improves the effectiveness of the program dramatically (...)management of the economy combined with the emphasis on technological adoption, development and dissemination are expected to help expedite the poverty alleviation program of the country.

Egbogah(www.spe.org/publications/tt/documents/v1n2_role_technology.pdf), observes that from the beginning of time, man has strived to improve his way and quality of life. The caveman discovered how to make and use tools, developed a logical sequence for activities, and evolved processes that added value to his life. The totality of the use and application of his knowledge, skills, tools, and materials constitutes what we today describe as "technology. Egbogah (ibid) ponders that:

(...) If natural instinct directs us and compels the application of technology for the well-being of man, why is it that all humankind has not exploited this in equal capacity? (...)
(Egbogahwww.spe.org/publications/tt/documents/v1n2_role_technology.pdf)

According to Egbogah (ibid), technology plays a fundamental role in wealth creation, improvement of the quality of life, real economic growth, and transformation in any society. Unfortunately in many if not all, of the non-developed (or "yet to develop") countries, technology is viewed as a consumable item, not something that can be produced or created. Technology is the primary engine of economic growth and provides the key to unlocking any country's potential. Hence, countries that want to develop must invest significantly in science and technology. This is achieved by developing the talent, the human capacity required to compete in a globally competitive world.

4.Science and Technology in Kenya: Strategies and Initiatives

In its long term development strategy outlined in Vision 2030, the Government of Kenya envisages a nation that is globally competitive and prosperous with a high quality of life by the year 2030. In pursuit of the vision, Science, Technology and Innovation is to be harnessed to stimulate technological and industrial transformation that will lead to sustained economic growth of 10 per cent per annum, and social well-being for a period of 25 years from the year 2008 (Republic of Kenya, , 2012a).

The Government of Kenya (Kenya, Republic of, 2012b) informs that in order to realize the above, the Government commits itself to facilitate the identification, acquisition, transfer, diffusion and application of relevant ST&I knowledge in all sectors of the economy. Through the National Science, Technology and Innovation and strategy, the Government purposes to harness Kenya's collective talents and creativity to promote capacity building in ST&I human, financial and infrastructure development and effective networks and linkages for knowledge generation and sharing. Strengthened science, mathematics and language skills will be critical in supporting Kenya's scientific, engineering and technology base. Equally important is the creating of enabling environment to apply these skills into productive and innovative competencies and opportunities for technological learning particularly within industry and business enterprises.

For sustained development to be realized, the Kenya Government notes that the efficiency gains must be enhanced and more importantly complemented with productivity growth. Science, technology and innovation will play a critical role in ensuring that productivity growth occurs, and that the economy is progressively transformed into knowledge based one. ST&I become central to the development of the existing economic sectors as well as the creation of new ones with high growth potential. ST&I is therefore identified as a foundation for Vision 2030, the long term economic plan that is set to guide the economy into a globally competitive and prosperous nation (Republic of Kenya, , 2012a).

Improved economic performance is based on significant growth across a wide range of sectors mainly as a result of efficiency gains. Generally, in Kenya the structure of the economy has remained unchanged and agriculture continues to contribute the largest share in the economy.

5. National Priority Sectors for ST&I Policy Interventions

The overall goal of ST&I is to generate knowledge and innovation to drive Kenya's Vision 2030. There is therefore need to review the existing ST&I policy and legal framework to make the sector more dynamic and responsive to global developments and national needs. The ST&I sector will require a major transformation to achieve the following:

(...) Re-align ST&I programmes to national goals and market needs; (...) Re-structure and rationalize the existing ST&I and R&D institutions to make them more effective in addressing national priority needs; (...). Establish institutions dedicated to developing key industries that will see the country attain NIC status; (...). Entrench product oriented multi-disciplinary approach to R&D; (...). Strengthen governance and management of the ST&I sector and institutions to make them more efficient and effective; and (...). Develop and implement a mechanism for sustainable financing of ST&I. (Kenya, Republic of, 2012a:7)

Lack of an integrative policy framework to facilitate effective delivery and utilization of knowledge and the integration of ST&I into the economy is an issue that needs urgent action. The productive sector does not have commensurate expertise that constitutes graduates from relevant institutions. This makes the private sector to incur higher costs in re-training staff for effective service delivery. Inadequate entrepreneurship skills mean that this cadre of expertise faces a barrier in the creation of ST&I technology-based enterprises within the economy.

The Kenya government (Republic of Kenya, , 2012a) shows that the national sectors significant to achievement of national growth and development targets are: Agriculture, Rural Development and related industries; Health and Life Sciences; Trade and Industry; Human Resource Development; Physical Infrastructure; Energy; Environment and Natural Resource Management and Information Communication Technology (ICT).

Agriculture, Rural Development and Related Industries: Priority areas in this sector are increasing the value of agricultural products through agro-business related processes, agro processing, agricultural research with special reference to bio-technology and drought management, address biotic and abiotic stresses that lead to losses due to pests and diseases. Application of ST&I is effected in production of fertilizers, seeds, animal breeds and irrigation technologies to reduce the cost of farming and improve land use to increase productivity. Science and technology create more value in the domestic market by removing inefficiencies in the supply chain by enhancing the quality and quantity of storage facilities, market access and pricing mechanisms.

Health and Life Sciences : This sector has priorities in developing the Kenyan health system to international standards through ST&I in Quality service and standards improvement, research in multi—sectoral health issues including infectious diseases, HIV/Aids, TB, Malaria and emerging infections, traditional knowledge and resources, and commercial production of traditional plants for medical use. It also involves streamlining inter-sectoral and public-private sector partnerships in state of the art medical technologies.

Trade and Industry: The sector has prioritized linkage between research findings and industry, diversification and upgrading of productive capacity of local industries, increasing adoption of new and appropriate technologies, promoting

utilization of IPRs and standards, promoting the growth of SMEs, increasing utilization of reverse engineering and increasing utilization of cleaner production techniques. In addition, the sector will strive to do provide requisite infrastructure and services for technological innovation and R&D to enable knowledge-based enterprises to grow and compete in the global marketplace; Utilize Science and Technology expertise for economic development especially for the rural community; Involve a business system that is critical to the process of acquiring and utilizing ST&I for national development needs. Kenya's industrial structure has insufficient linkages between various categories of firms especially the medium and small-scale enterprises where most innovations take place. There has been limited participation of these firms in the industrial sector leading to inadequate stimulation and improvement in technology imports.

Human Resource Development: Human resource development in respect of ST&I aims at skills development and management. Education and training ensures the supply of adequate and competent human resource necessary for rapid ST&I development. Changes needed include high quality, relevant, equitable and accessible education and training. One of the main areas is education Infrastructure such as physical, energy, communication and ICT. The other priority is the creation of a critical mass of a human resource to support ST&I development and sustainability. In the Kenyan context, education, research and training institutions are weak for a variety of reasons ranging from inadequate staffing, funding and lack of linkages among others. There is also a gap between generation of knowledge in such Institutions and its application across the country.

Physical Infrastructure: Infrastructure is a prerequisite for effective utilization of science, technology and innovation. Lessons from global experience suggest that infrastructure development provides an important lever through which a nation can enhance its level of technological development. This is through its contribution to effective utilization of ST&I. It will also enhance potential positive impact on enhancing the technological learning process. Clearly, therefore, the inadequate state on infrastructure and the services thereof in Kenya presents an important opportunity through which Kenya can leapfrog in its application of science technology and innovation. Priorities in this sector will involve infrastructure development process to enhance the country's technological foundation, improve technological innovation as well as the technological learning processes. Measures in this sector will include reforming the legal, Institutional and regulatory frameworks with a view to enhancing proper infrastructure design, integrity in contract procurement, enhancing safety, proper and timely maintenance, allowing for private sector and community participation. It also involves integration of information technology network to improve performance and create seamless, efficient and cost effective telecommunication services for business and social interaction.

Energy, Environment and Natural Resource Management: Vision 2030 growth targets are expected to make significant demands for relatively cheap, affordable, reliable and clean energy. In this regard the sector priorities will be research and development for efficient energy use and conservation practices; research and analysis of waste management and utilization of the same for energy production; exploration to establish the availability and use of alternative energy sources; as well as capacity building and human resource development in all areas of engineering and technical fields in the sector. The sector comprises forest, water, mining and minerals and wildlife. The priority areas of interventions in this sector include biodiversity conservation, forest and environmental management. Knowledge-based technologies provided by ST&I are necessary to reinforce the current efforts designed for the management of environment and natural resources.

Information Communication Technology (ICT): The ICT sector will intensify training efforts to build capacity in ICT, facilitate development and growth of a robust ICT and infrastructure to stimulate and support local ICT industry growth, improve delivery of service to private organizations and businesses, streamline registration and licensing through e-government, leverage ICT and provide a stable umbrella for public-private sector growth, integrate and popularize the use of ICT in learning institutions, workplaces and rural communities. It will also involve development of a network of ST&I resource centres which will be linked to other centres locally, regionally and internationally.

The ST&I Policy and Kenya Vision 2030

The Kenya Vision 2030 and the Millennium Development Goals are the twin strategies adopted by the Government of Kenya to reduce poverty and enhance access to basic needs. Science, Technology and Innovations are recognized nationally and globally as essential for the economic transformation, growth and competitiveness of Kenya and are also key components of social integration, sustainable development and poverty eradication. Implementation of relevant Science, Technology and Innovations strategies in Kenya must be successfully delivered in order to achieve the goals set under the Kenya Vision 2030(Kenya, Republic of, 2012a).

The Science, Technology and Innovation (STI) sector seeks to integrate knowledge into all production systems of the Kenyan economy. The policy and strategy regime pursued by the sector seeks to achieve key objectives of enhanced quality of outcomes in Research, Science, Technology and Innovation (RSTI) as well as strengthened governance and management at sector at institutional levels and further ensure financial sustainability of the sector. The purpose is to ensure an improved and efficient environment in which RST&I business is conducted for the achievement of the Vision 2030. This ST&I Policy seeks to achieve the following objectives:

(...) Strengthening the technical capacities and capabilities of ST&I, UE and TVET institutions and systems; (...) developing a core mass of highly skilled human resources; intensification of innovation in priority Sectors including setting up a functional National Innovation System and (...) enhancing awareness on the role of knowledge in enhancing productivity among policy makers, implementers and beneficiaries(Kenya, Republic of, 2012a:4).

6. Leveraging ST&I for National Development in Kenya: The Key Challenges

Although the constitution has emphasized the importance of science, technology and innovation in Kenya's development, the sector continues to operate in a fragmented manner losing on the benefits of synergy and networking. The investments that Kenya has made in science and technology infrastructure have not yielded the expected improvements in economic growth. This can be attributed to a number of challenges including the following:

- a) The NCST has operated as a department in a Ministry. This rendered the Council ineffective as it failed to coordinate R&D in the more autonomous and generally better endowed Research Institutes. b) There has been no national research agenda to guide the researchers. Each research institute and university has developed their own research programmes without regard to what the others were doing. c) The linkages between the researchers, innovators and industry who are expected to use the research outcomes, are weak. The result has been the lack of commercialization of research findings (...)(Kenya, Republic of, 2012a:7)
- b) Funding for research has been very low. Researchers have had to rely on foreign funding with the attendant danger of pursuing a foreign agenda. e) The structure and mix of products from the local industry has not stimulated innovation. Most industries are engaged in retailing of other companies products hence the demand for Research, Development and Innovation (RDI) has been minimal. f) The non-alignment of the research agenda with national development goals and market needs so as to attract more funding for ST&I (...).The inadequate scientific expertise in the country due to over reliance on foreign experts leading to the neglect of the development and use of local expertise. h) Lack of advocacy for ST&I at high political and policy levels. i) Low science culture among the population. j) Weak mechanisms for implementation, evaluation and review of ST&I initiatives (...) Weak linkages between various agencies and organizations in ST&I. (...) and Poor performance in Mathematics and Sciences in Secondary schools which lays the foundation of science expertise. (Republic of Kenya, , 2012a:7)

7. Kenya's Science and Technology Policies and Strategies

Kenya's Science and Technology policies highlight areas meant to create an enabling environment for the growth of ST&I. The policies fall within the four strategic thrusts used to address challenges in the ST&I sector which include; lack of an integrative policy framework to facilitate effective integration of ST&I into the economy; lack of a coordinated national research agenda; the existence of a linear and fragmented innovation system; Silo Mentality of researchers; weak linkages and ineffective coordination between government, private sector and researchers; non-alignment of academic curricula and graduate SET skills to industry needs; low commercialization rate of innovations; IP process is perceived as complex and low awareness among innovators; data does not exist to measure innovations; inadequate funding and support for innovations.

Policy 1: The government will establish an institutional and regulatory framework to promote, coordinate, mobilise resources and manage ST&I. Strategies to implement this policy include the following:

(...) Mainstream ST&I in all sectors of the economy both at national and county government levels; (...) Re-engineer institutions to provide a governance framework to support autonomy, coordination, gender parity and partnership-based application of ST&I; (...)Provide guidelines for monitoring compliance with ethical issues regarding research activities; (...) Build capacity for quality standards and accreditation of testing and calibration

laboratories according to international requirements; (...) Establish a strong, supportive and comprehensive policy environment for speedy and effective commercialisation of inventions and innovations to maximise public good and interest; (...) Promote local ST&I inventions and innovations and ensure that the innovators receive appropriate compensation or royalties; and (...) Develop, implement, continuously review and globally benchmark a comprehensive performance management framework. (Republic of Kenya, , 2012a:20)

Policy 2: The government through relevant institutions will leverage ST&I to transform the economy through identified national priority areas including:

(...)Telecommunication, Electronics and Computers (TEC) manufacturing technologies; (...) Software development technologies; (...)Automobile manufacturing technologies; (...)Satellite and space infrastructure manufacturing technologies; (...)Renewable and green energy infrastructure manufacturing technologies; (...) Nuclear energy technologies; g) Food and nutritional security technologies; (...) Natural resource management technologies; i) Health technologies; (...)New and emerging technologies(...) (Kenya, Republic of, 2012a:21).

In order to implement the policy, the government will adopt the following strategies;

(...) Establish and sustain network of innovation Centres of Excellence in the national priority areas with specific deliverables. (...) Identification, evaluation and acquisition of appropriate technologies supportive of the realization of the identified national priority areas to ensure that they are evidence-based and demand-driven (...) Review all on-going ST&I interventions and align them to the national priority areas (...) Establish and continuously review a Framework for conducting fore sighting linked to the national priority areas (...) Promote the formation of new technology-based firms through the establishment of ST&I Parks. (Republic of Kenya, , 2012a:21).

Policy 3: The government will allocate 1% of GDP annually for the R&D sub-sector and motivate other stakeholders to participate in funding ST&I. In order to implement the policy, the government will adopt the following strategies;

(...) Increase public investment for universities, government laboratories and research institutes to enable access to facilities and equipment; (...) Create a National Research Fund to support both basic and applied research; (...) Establish infrastructure and equipment needs for ST&I to support overall national development objectives; (...)Finance the established ST&I infrastructure and equipment needs; (...) Develop globally benchmarked ST&I infrastructure to support intervention in strategic priority areas; (...) Create incentives for industry and other stakeholders to co-fund the innovation and commercialization; (...) Create a framework for venture capitalists and angel investors to finance innovative ideas in national priority areas; (...) The short to medium term, utilization of funds will lay emphasis on identification of existing domestic and foreign technologies and adapting these to address our identified national priorities; (...) Over the medium to long-term, there will be a shift of public resources to growth-engine technologies. (Kenya, Republic of, 2012a:21f).

Policy 4: The government in collaboration with relevant stakeholders will identify, nurture, recognise and protect intellectual property rights of scientists, researchers and innovators. In order to implement the policy, the government will adopt the following strategies; a) Establish the status of the national ST&I human resource capacity and skills in science, engineering and technology, identify the gaps and address the deficient areas; b) Facilitate involvement of women, youth and disadvantaged groups and other stakeholders in national governance and public policy making to ensure policies are all inclusive; c) Document, evaluate and continuously update the extensive indigenous resources and traditional knowledge and integrate them into national development to enhance utilization; d) Develop a mechanism to retain the highly talented Kenyans from our education system and attract the best from the Diaspora; e) Develop a framework for enhancing creativity and learning by discovery through promotion of appropriate content of SET and entrepreneurship skills at various levels of education and training; (Kenya, Republic of, 2012a).

The fourth policy further mentions that the government will:

(...)Recognize, tap, nurture and reward ST&I talent through compensations and royalties from the early stages of learning in all sectors by utilizing competitions, exhibitions, sciences congresses among others; (...)Ensure Intellectual Property Rights (IPR) regime facilitates the identification generation, acquisition and protection of indigenous (including genetic) resources and traditional knowledge; (...) Develop IPR programmes that effectively

harness ST&I utilization for the rapid commercialization of intellectually protected products and services locally and internationally to maximize on public good and interest; (...) Review and implement a National Intellectual Property Policy and enlist supportive international actions to exploit and protect technological innovations arising out of genetic resources, traditional and cultural expressions and scientific investigations; (...) Promote innovative in-house R&D in both public and private enterprises through incentive schemes and Public Private Partnerships (PPPs). (Kenya, Republic of, 2012a: 22).

Policy 5: The government will establish and promote ST&I knowledge sharing and awareness creation systems. In order to implement the policy, the government will adopt the following strategies:

(...)Develop and implement dynamic ST&I communication policy (...) Establish and sustain national integrated advocacy programmes such as encouraging Science, Mathematics and Technology in Schools. (...) Promote public awareness, acceptance and support for national science, technology and innovation activities. (...) Develop a framework in a participatory manner to promote technological learning within the public sector to close the competency and knowledge gaps between policy makers and industry practitioners (...) Establish national and county ST&I museums (...) Promote the generation, documentation and dissemination of ST&I information (...) Promote public dialogue involving researchers, the different users and beneficiaries on ST&I matters of interest through print, electronic and other media (...) Develop mechanisms for communicating ST&I results to increase knowledge and understanding for adoption and utilization (...) Establish a knowledge management information system for disseminating and sharing research findings (...) Develop and implement an effective and efficient web-based mechanism for monitoring, reviewing and reporting of ST&I policy implementation process (...) Support and encourage the development of indicators for ST&I. (Kenya, Republic of, 2012a:23f).

8. The Role of Universities of Technology in National Development

According to Ilemobade (n.d), universities can be classified as: Conventional, Technological or Open. Conventional University is a multipurpose one which aims to train all round excellence in sciences and humanities. It is generalist in its approach and in its emphasis. The Technological University on the other hand, has as its focus as the application of knowledge for "the specific purpose of fostering technological advance, its strength is practical. The Open University is essentially an improvement of the extension service which exploits the media and printed word for the specific purpose of bringing higher education into the homes. It is a pragmatic approach to solving increasing demands for higher education at less cost.

The need for a University of Technology stems from the well-founded conviction that science in its applied form has had minimal impact on total national effort in development. If therefore, technology is regarded as the main pillar of drive towards self-sufficiency, it is only right and proper that something concrete be done to give expression to the feeling. Hence Universities of Technology are established. Ilemobade (n.d) writes that:

(..) Universities of Technology are by their very nature, an innovation in the nation's educational system and in drive to achieve self-reliance in the development of higher education and high level manpower resources (...) These Universities are not just additional universities, not just an expansion of university opportunity: they must; be different from the traditional universities which we inherit from the past (...) (Ilemobade, n.d:5)

Universities of Technology must aim at not merely imparting theoretical knowledge, but, at giving greater emphasis to practical experience in the field and the development of appropriate skills by their students.

(...) in other words the products of these Universities must be finished products" so to speak, in the sense that they can be gainfully employed, within their fields of specialization, on graduation (...) (Ilemobade, n.d:5).

Ilemobade (n.d) notes that some have argued that the Universities of Technology are at best a duplication of faculties of engineering and technology in conventional universities and should not be established to compete for scarce resources which could be used to revamp and expand existing faculties of engineering and technology in the conventional universities. In this regard Ilemobade (n.d) holds that:

(...) Fortunately, many people (...) hold a different view. First, just as it is much more difficult to mould the character and growth of an adult than those of a child, so it is with the conventional universities vis-à-vis

universities of technology (...). Second, universities of technology are established for a specific purpose of generating technology, whereas the conventional universities, even when they tried to generate technology, have significant institutional constraints militating against the sustenance of technological tempo, for example, the fierce competition for resource allocation. Third (...) the establishment of universities of technology hinges on the need to facilitate indigenous technological changes and thus obviate the craze to depend on technology transfer which is a mirage (...). Fourth, the universities of technology would serve as a potent catalyst for creating technology culture in a country. (Ilemobade, n.d:6)

The Mission of Universities of Technology

According to Ilemobade (n.d), an institution needs a sense of mission for, survival and sense of commamission implies a realization that choices have to be made about its role. If we are to properly evaluate the role of universities of technology in national development, therefore, we must be able to see distinct roles and orientation as reflected in their objectives. Ilemobade (n.d), discusses that while universities have different patterns of evolution, their purposes could generally be said to be to:

(...) (a) assist through training with programmes in manpower development (...) (b) advance the frontiers of knowledge through searching (...) for truth, discovering, storing and disseminating knowledge (...) (c) provide service through constant interaction with the community and be critics of society (...)(Ilemobade, n.d:6)

The zeal with which any university pursues these functions would depend on its human and material resources. In the case of the universities of technology the objectives are:

(a) to encourage the advancement of learning and hold out to all persons without distinction of race, creed, sect or political conviction the opportunity of acquiring higher education on technology (...); (b) to develop and offer academic and professional programmes leading to the award of diplomas, first degrees, postgraduate research and higher degrees which emphasize meaningful, adaptive, technical, maintenance, developmental and productive skills in the engineering, scientific, agricultural, medical and allied professional disciplines with the aim of producing socially mature men and women with capability not only to understand, use and adapt existing technology but also to improve on it and develop new ones;

(c) to act as agents and catalysts; through postgraduate training, research and innovation for the effective and economic utilization, exploitation and conservation of the countries natural, economic and human resources; (d) to offer to the general population, as a form of public service, the results of training and research and to foster the practical applications of these results; (e) to establish appropriate relationships with other national institutions involved in training, research and development of technologies (...)(f) to identify the technological problems and needs of the society and to find solutions to them within the context of overall national development; (g) to provide and promote sound basic scientific training as a foundation for the development of technology and applied sciences, taking into account indigenous culture and the need to enhance national unity; (h) to undertake any other activities appropriate for a University of Technology of the highest standard. (Ilemobade, n.d:6f).

The Objectives of the Universities of Science and Technology in National Development

Ilemobade (n.d), argues that if the Universities of Technology must be relevant to national development, the objectives and orientation must reflect national aspirations in technology, the major ones being:

(a) the supply of indigenous technological manpower through training and retraining;(b) the development of appropriate technologies for the utilization of our agricultural and mineral resources; and (c) the sourcing of industrial raw materials. (Ilemobade, n.d:8).

9. An Overview of Universities of Science and Technology in Kenya

As at the time of writing this paper (February, 2013) Kenya had six universities based on Science and Technology. These universities are: Jomo Kenyatta University of Agriculture and Technology (JKUAT), Masinde Muliro University of Science and Technology (MMUST), Dedan Kimathi University of Technology (DKUT), Kiriri Women's University of Science and Technology (KWUST), Meru University College of Science and Technology (MUCST), and Jaramogi Oginga Odinga University of Science and Technology (JOOUST).

Jomo Kenyatta University of Agriculture and Technology (JKUAT)

Jomo Kenyatta University of Agriculture and Technology (JKUAT) was started by the Government of Kenya with the assistance from the Japanese Government in 1981 as a MiddleLevelCollege in the name of Jomo Kenyatta College of Agriculture and Technology (JKCAT). On 4th May 1981, the first group of students joined the college, and later, in April 1984, graduated with Diploma Certificates in Food Technology, Agricultural Engineering and Horticulture. On 17th March 1982, the College was formally opened. On 1st September 1988, through a legal Notice, JKCAT became a constituent College of Kenyatta University under the Kenyatta University Act (CAP 210C). JKCAT changed its name to Jomo Kenyatta University College of Agriculture and Technology (JKUCAT), and finally established as a University with inauguration on 7th December 1994 through the JKUAT Act hence JKUAT.

JKUAT posts on its website (www.jkuat.ac.ke.) that it envisions being a University of global excellence in Training, Research and Innovation for development. The university has its mission as offering accessible quality training, research and innovation in order to produce leaders in the fields of Agriculture, Engineering, Technology, Enterprise Development, Built Environment, Health Sciences, Social Sciences and other Applied Sciences to suit the needs of a dynamic world. JKUAT has a motto that emphasizes on research and innovation in higher education, with objectives steered towards collaboration, effective role and cooperation in technological advancement in higher learning. The university has a total of eight core values that include quality, teamwork, transparency, accountability, professionalism, innovativeness, integrity and dynamism. In addition, JKUAT has a university philosophy that reiterates on endeavors in attracting, developing, motivating and retaining a skilled and consultative workforce.

JKUAT offers a variety of courses in certificate, diploma, bachelor and postgraduate studies. The certificate courses comprise of bridging in Mathematics, certificate in HIV/AIDS Management, and certificate in Information Technology. The postgraduate courses comprises of Masters in fields of business, agriculture, engineering, physical sciences, management, among others. The postgraduate courses also include philosophy of doctorates in engineering, mathematics, physical sciences and business management. JKUAT has a category of bachelors' programs in information technology, management, chemical sciences, biological sciences, engineering, and others. Diploma courses in JKUAT include Diploma in Clinical Medicine, Diploma in HIV/AIDS Management, Diploma in Architecture, Diploma in Business Administration, Diploma in Business Information Technology, Diploma in Food TechnologyDiploma in Information Technology and Diploma in Purchasing & Supplies Management.

JKUAT has partnered and collaborated with several institutions both within and outside Kenya to facilitate its research and innovation in its training. For instance, the university collaborated with the African Advanced/level Telecommunication Institute – Nairobi in 2009/2013 in Cisco training, and with the BourneMouthUniversity – UK in 2010/2015 in capacity building. Other institutions of collaboration are Denver University of USA, Kaduna Polytechnic of Nigeria, Kaisers Lautern University of Germany, Oslo School of Architecture of Sweden, among many others.

Kiriri Women's University of Science and Technology (KWUST)

KWUST is privately owned, and trains only women. The university was inceptioned with an objective to bridge the gap in gender parities in education in the region. The University posts on its website that:

(...) the university has been transforming the lives of many young women, not just in Kenya and Africa but the world in general (<http://www.kwust.ac.ke>).

The Government of Kenya, through the Commission of Higher Education, issued a Letter of Interim Authority on 15th May 2002 in the set up of the institution. KWUST has three schools in categories of training that include School of Business and Management, School of Computer and Information Technology, and School of Science (Mathematics, Physics, biological Sciences, Environmental Science, and Chemistry).

The KWUST vision is to be a centre of academic excellence in the scientific and technological formation and promotion of the full and holistic development of the individual as a responsible member of the human community. Its mission is to educate and train individuals in the search for truth and knowledge through scientific methods while the philosophy holds that science and technology is the tool to reap and utilize resources sustainably, with a motto of using education to empower women. Among its core values is excellence, patriotism, respect, professionalism, transparency, among others.

KWUST offers causes in bachelors' degrees, diplomas, bridging and pre-university. Degree courses include Bachelor of Science in Computer Science and Mathematics, whole the diplomas are in Business Administration, Portfolio

Management, and ICT. Bridging courses are offered for Mathematics, English and Physics. On the other hand, the pre-university courses are designed to develop skills in learning before joining for higher courses. However, the university has upcoming courses which include:

(...) Bachelor of Science in Information Systems; Diploma in Computer Programming; Diploma in Information Systems, Bachelor of Science in Nursing; Diploma in Nursing (...) Bachelor of Law (LLB); Diploma in Law; Bachelor of Education (Science Option); Bachelor of Education (Humanities and Arts Option); Postgraduate Diploma in Education (...) (<http://www.kwust.ac.ke>).

Kiriri Women's University of Science and Technology has partnered with other institutions to develop its academics. For instance, Kiriri is a member to the Women's Education Worldwide which brings together Presidents, Vice Chancellors, Chief Academic Officers of Women's Colleges and Universities from around the world. Through this partnership, KWUST has achieved in collection and dissemination of data about women's institutions.

Dedan Kimathi University of Technology (DKUT)

Dedan Kimathi University of Technology developed from a community project, and then known as Kimathi Institute of Technology (KIT) in 1972. The first students were admitted into the institution in 1978, whereby it grew to one of the leading institutions in Kenya in the training of Certified Public Accountants. The Institute was upgraded to University status in 2007 under the constituent of Jomo Kenyatta University of Agriculture and Technology. On 14th December, 2012, the institute was granted a charter to become a fully-status university, hence the name Dedan Kimathi University of Technology (DKUT). The university's motto is to Better Life through Technology, while the vision statement seeks a technological University that excels in quality Education, Research and Technology for national development. The university's mission is providing learning that recognizes diversity while incorporating research, technology and innovation for relevant human resources in national development. The philosophy of DKUT calls for being as good as the best in the world. DKUT has six core values namely innovation, scholarship, diversity, reliability, teamwork, and nature and heritage (<http://dkut.ac.ke>).

DKUT offers courses for both graduates and undergraduates. School of engineering offers Masters in Industrial Engineering and Management, and Bachelors in Engineering in electrical and electronic, telecommunication and information, mechanic and civil. School of Business offers undergraduate, graduate (MBA and PhD), and Executive Education programs. Masters in Business Administration have options for Leadership and Organizational Management, Accounting, Finance, International Business, Marketing, and Strategic Management. Bachelors' programs are in Purchasing and Supplies Management (BPSM), Business Information Technology (BBIT), Commerce (BCOM) and Business Administration (BBA). Diploma courses in the School of business are Diploma in Business Administration and Diploma in Purchasing and Supplies Management while Certificate course is offered in County Governance.

Moreover, DKUT has schools of Science categorized into two as Computer Science and Health Science that offer various programs in bachelors and diplomas. The university has various institutes that include institute of geomatics, GIS & remote sensing (IGGRS) that offer respective courses. Institute of Technical and Professional studies offers programs such as Diplomas and Certificates in Clothing and Fashion Design, Furniture Technology and Interior Design, Building Technology, and Metal Work, Welding and Design. Other institutes in the university are institute of food bio-resources which offers courses in coffee technology, and institute of Tourism and Hospitality Management.

Masinde Muliro University of Science and Technology (MMUST)

Masinde Muliro University of Science and Technology was founded 5th January, 1972 through community self-help spirit, and was by then called Western College of Arts and Applied Sciences (WECO). The first batch of students at WECO enrolled for certificate and diploma courses in 1977. The courses consisted of the programs in mechanical and motor vehicle, electrical, electronic, agriculture, architecture, among others. The institutions' name hanged to Western University College of Science and Technology (WUCST) in December 2002 as a constituent college of Moi University. Later on, in 2007 WUCST was elevated to a fully- status university hence the name changed to Masinde Muliro University of Science and Technology (<http://www.mmust.ac.ke>) .

MMUST envisions being a center of excellence in science and technology responsive to development needs of society through engagement in dynamic knowledge creation and application. The university's mission is bound on widening knowledge dissemination through integrating science and technology, research and innovations. It has a

general objective of qualitative contribution to economy through sustainability and equitability. The university's philosophy emphasizes science and technology as an important tool in harnessing resources for development. The university offers courses in engineering, education, social sciences, disaster management, preparedness and mitigation. Other courses include health (Medicine) information technology, among others. MMUST also has Institute of Graduate Studies, Research and Extension (IGSRE), Science and Technology Park and Industrial Linkages (STPIL), Forensic Science, Banking Fraud and Money Laundering Investigations; Corruption Research, Monitoring and Evaluation; Corruption Prevention Methods. Others are Audit and Planning Logistics, Conflict Management and Resolution among others.

Meru University College of Science and Technology (MUCST)

Meru University College of Science and Technology (MUCST) was established in mid-1960s after Kenya's independence to serve the needs of development of the youth in anticipated industries. It started as Meru College of Technology (MECOTECH). In 1979, the college opened its first office in Meru Municipal Hall. In 1983, the first students were admitted for a two year course in Agriculture. In May 1985, a Motor Vehicle Mechanics course was introduced and followed by the Building Technology Craft I – III courses in 1987. Accounts and Secretarial Studies (Intermediate and Final) courses were introduced in September 1992 and May 1993, respectively, which then steered the college into offering diploma and certificate courses in engineering, agriculture and extension, Information Technology, secretarial, building and masonry and business administration, among others (<http://www.mucst.ac.ke>).

MUCOTECH was elevated to a University in 2008 and named the Meru University College of Science and Technology (MUCST). It was established as a constituent college of Jomo Kenyatta University of Agriculture and Technology. In May 2009, MUCST admitted its first degree programmes' students in Bachelor of Commerce (B-COM), Bachelor of Business Information Technology (BBIT), and Bachelor of Science in Information Technology (B.Sc. IT). MUCST has a vision of being a world class university of excellence in science and technology.. The university's mission is to provide quality university education for globally competitive graduates through training, research, and innovation while core values are relevance, competitiveness, quality, efficiency, transparency, among others.

MUCST offers a range of courses on programmes under various schools. For instance, the school of information technology and engineering offers Bachelors in computer science, computer technology, Information Technology; and Diploma in IT, Engineering, Building Construction, and certificates in respective courses. The School of Agriculture and Food Science has courses offered in Bachelors degrees of Science in food and technology, Horticulture and Agribusiness, while Diploma courses in Agricultural Education and Extension and in Agriculture. The School of Pure and Applied Sciences which have various Departments including Department of Mathematics and Physics, Department of Chemistry, Department of Biological Sciences and Department of Health Sciences offering respective programmes of Bachelor, Diploma and Certificates. Lastly, MUCST has a School of Business and Economics with three Departments, namely: - Depart of Accounting and Finance, Department of Business management, and Department of Economics, all offering Masters, Bachelors, Diplomas, and Certificate courses(<http://www.mucst.ac.ke>)..

Jaramogi Oginga Odinga University of Science and Technology (JOOUST)

Jaramogi Oginga Odinga University of Science and Technology (JOOUST) was first established as Bondo University College (BUC) through a Legal order No. 56 of 11th May 2006, and as a constituent college of Maseno University. JOOUST's vision is to become the best in research, training and sustainable development while the mission is to provide quality university education that nurtures creativity and innovation through integrated training, research and community outreach.. The University has six core values namely fairness, professionalism, transparency and accountability, integrity, meritocracy, and gender equity. The philosophy of the university is to use science and technology to create a holistic approach of service to humanity. Courses offered at JOOUST fall within the broad categories of schools as follows: School of Education and Social Sciences, School of Biological and Physical Sciences, School of Engineering Sciences and School of Food Security, Agriculture and Biodiversity. The four Schools offer a variety of respective courses from the Doctorate to Diploma ones(<http://www.bondo-uni.ac.ke>).

10. Leveraging Science and Technology for National Development: Implications for the Universities of Science and Technology in Kenya

From the discussions of this paper, universities of science and technology in Kenya have key roles in the development of

sectors of the country namely economic, social and political. In the economic sector, these universities have a role to play in ensuring the supply of the labour and instruments required to meet the production needs in the economic sector. Socially these universities would feel gaps in the areas of communication, thereby facilitating creation, dissemination and storage of knowledge and related information for a common understanding. When economic and social demand needs are met, the political situation becomes sound and the population is well informed thereby not being exploited or oppressed. To achieve these desires, there are general and pedagogical implications for the universities of science and technology to leverage national development in Kenya.

General Implications

This paper has underscored the role of science and technology in national development. Science and technology facilitates knowledge creation and application which is vital to economic growth, global competitiveness and meaningful employment creation. It is recognized that effective leveraging of science, technology and innovation is essential for wealth creation in all nations. Science, technology and innovation is also a key component of social integration, sustainable development and poverty eradication based on equity, freedom, justice, governance, peace and prosperity. At the international level, science, technology and innovation act as a tool of international co-operation and solidarity. It is useful for provision of knowledge and information as well as facilitating globalization with human development while concomitantly strengthening national governance and acting as a vector of common heritage, international cooperation and solidarity. Appropriate Science, Technology and Innovation policy is key to the production, distribution and use of knowledge and information. In its Science, Technology and Innovation Policies and Strategies, the Kenya government underscored these needs for the Kenyan people, and these become the main interest of the universities of science and technology in Kenya.

This paper argues that to achieve the aspirations of the Kenyan people in their quest for national development universities of Science and Technology in Kenya will have to set their objectives to reflect the national aspirations in technology. In Kenya at the moment the overall goal of ST&I is to generate knowledge and innovation to drive Kenya's Vision 2030. This way, universities of science and technology in Kenya need to align and have orientation with Kenya's national priority sectors for science, technology and innovation policy interventions

As argued in this paper, for universities of technology to be relevant to national development, their objectives and orientation must reflect national aspirations in technology. This way, the major objectives have been shown to be (a) the supply of indigenous technological manpower through training and retraining; (b) the development of appropriate technologies for the utilization of our agricultural and mineral resources; and (c) the sourcing of industrial raw materials. Whereas these objectives may not be directly relevant to any country specific, universities of science and technology in Kenya may borrow a leaf from them and set their individual orientation to suit specific needs.

From the overview of the universities of science and technology done in this paper, it has been shown that each of the six universities of science and technology in Kenya has a mission. As Illembade (n.d), points out, an institution needs a sense of mission for, survival and sense of mission implies a realization that choices have, to be made about its role. If we are to properly evaluate the role of universities of technology in national development, therefore, we must be able to see distinct roles and orientation as reflected in their objectives .

Each of the universities of science and technology in Kenya will need to have their roles clearly implied in their mission. This paper argues that for this to be realized, these universities must be different from conventional universities. Conventional University is a multipurpose one which aims to train all round excellence in sciences and humanities. It is generalist in its approach and in its emphasis. The Technological University on the other hand, has as its focus as the application of knowledge for "the specific purpose of fostering technological advance, its strength is practical. The Open University is essentially an improvement of the extension service which exploits the media and printed word for the specific purpose of bringing higher education into the homes. It is a pragmatic approach to solving increasing demands for higher education at less cost.

The need for a University of Technology stems from the well-founded conviction that science in its applied form has had minimal impact on total national effort in development. If therefore, technology is regarded as the main pillar of drive towards self-sufficiency, it is only right and proper that something concrete be done to give expression to the feeling. Hence Universities of Technology are established. Universities of Technology are by their very nature, an innovation in the nation's educational system and in drive to achieve self-reliance in the development of higher education and high level manpower resources. These Universities are not just additional universities, not just an expansion of university opportunity: they must; be different from the traditional universities which we inherit from the past. Universities of

Technology must aim at not merely imparting theoretical knowledge, but, at giving greater emphasis to practical experience in the field and the development of appropriate skills by their students.

This paper argues that underscoring the above general implications is necessary but not sufficient condition to leverage science and technology in Kenya's national development. This is because such implications cover much of the administrative and structural aspects of the university but not the actual process of teaching and learning. It is in this regard that this paper endeavours a discussion on pedagogical implications.

Pedagogical Implications

This paper defines pedagogy as the social intercourse between the teachers and learners to bring about a relatively permanent change in behaviour (learning). This social intercourse encompasses teaching methods and approaches, role of teachers and learners in this exercise and generally the environment within which the process takes place. To leveraging science, technology for national development, the universities of science and technology in Kenya would need to be void of narration sickness pedagogy and embrace problem-posing approach.

Narration Sickness

According Freire (2005), narration sickness in education is a relationship that involves a narrating Subject (the teacher) and patient, listening objects (the students). This results in a situation in which values or empirical dimensions of reality, tend in the process of being narrated to become lifeless and petrified. This way, the teacher talks about reality as if it were motionless, static, compartmentalized, and predictable. Or else he expounds on a topic completely alien to the existential experience of the students. The teacher's task is to "fill" the students with the contents of his/her narration, contents which are detached from reality, disconnected from the totality that engendered them and could give them significance. Words are emptied of their concreteness and become a hollow, alienated, and alienating verbosity.

Freire (2005), discusses that the outstanding characteristic of this narrative education, then, is the sonority of words, not their transforming power. Education thus becomes an act of depositing, in which the students are the depositories and the teacher is the depositor. Instead of communicating, the teacher issues communiques and makes deposits which the students patiently receive, memorize, and repeat. This is the "banking" concept of education, in which the scope of action allowed to the students extends only as far as receiving, filing, and storing the deposits.

The banking concept of education regards learners as adaptable, manageable beings. The more students work at storing the deposits entrusted to them, the less they develop the critical consciousness which would result from their intervention in the world as transformers of that world. The more completely they accept the passive role imposed on them, the more they tend simply to adapt to the world as it is and to the fragmented view of reality deposited in them (Freire, 2005). The capability of banking education to minimize or annul the students' creative power and to stimulate their credulity serves the interests of the oppressors, who care neither to have the world revealed nor to see it transformed. The oppressors use their "humanitarianism" to preserve a profitable situation. Thus they react almost instinctively against any experiment in education which stimulates the critical faculties and is not content with a partial view of reality but always seeks out the ties which link one point to another and one problem to another.

According to Freire (2005), those who use the banking approach, knowingly or unknowingly (for there are innumerable well-intentioned bank-clerk teachers who do not realize that they are serving only to dehumanize), fail to perceive that the deposits themselves contain contradictions about reality. But, sooner or later, these contradictions may lead formerly passive students to turn against their domestication and the attempt to domesticate reality. Freire (2005), informs us that implicit in the banking concept is an assumption of a dichotomy between human beings and the world: a person is merely *in* the world, not *with* the world or with others; the individual is spectator, not re-creator. In this view, the person is not a conscious being (*corpo consciente*); he or she is rather the possessor of a consciousness: an empty "mind" passively open to the reception of deposits of reality from the world outside.

It follows logically from the banking notion of consciousness that the educator's role is to regulate the way the world "enters into" the students. The teacher's task is to organise a process which already occurs spontaneously, to "fill" the students by making deposits of information which he or she considers to constitute true knowledge. And since people "receive" the world as passive entities, education should make them more passive still, and adapt them to the world. The educated individual is the adapted person, because she or he is better "fit" for the world. Translated into practice, this concept is well suited to the purposes of the oppressors, whose tranquility rests on how well people fit the world the oppressors have created, and how little they question it (Freire, 2005).

Freire (2005), observed that the more completely the majority adapt to the purposes which the dominant minority prescribe for them (thereby depriving them of the right to their own purposes), the more easily the minority can continue to prescribe. The theory and practice of banking education serve this end quite efficiently. Verbalistic lessons, reading requirements, the methods for evaluating "knowledge," the distance between the teacher and the taught, the criteria, for promotion: everything in this ready-to-wear approach serves to obviate thinking. It is in this regard that Freire called for authentic thinking in pedagogy. Pedagogy is understood in this paper as the social intercourse between teachers and learners. Authentic thinking informs the basis of the position against narration sickness in higher education.

From Narration Sickness to Problem-posing Approach

As understood from Freire's banking concept of education, narration sickness leads to an act of oppression in the teaching-learning process. According to Freire (2005), an act is oppressive when it prevents people from being more fully human. This way, narration sickness as seen from the banking concept of education prevents learners from being more fully human. It is the thesis of this paper therefore that the objectives of university education in Kenya as outlined in the Universities Act 2012 would be more effectively achieved when students become fully human. Becoming fully human requires an interaction between lecturers and students that permeates authentic thinking.

While calling for authentic thinking Freire (2005) noted that solidarity requires true communication, and the concept by which such an educator is guided fears and proscribes communication. Yet only through communication can human life hold meaning. The teacher's thinking is authenticated only by the authenticity of the students thinking. The teacher cannot think for her students, nor can she impose her thought on them. Authentic thinking, thinking that is concerned about *reality*, does not take place in ivory tower isolation, but only in communication. If it is true that thought has meaning only when generated by action upon the world, the subordination of students to teachers becomes impossible.

Those truly committed to liberation must reject the banking concept in its entirety, adopting instead a concept of women and men as conscious beings, and consciousness as consciousness intent upon the world. They must abandon the educational goal of deposit-making and replace it with the posing of the problems of human beings in their relations with the world. "Problem-posing" education, responding to the essence of consciousness; *intentionality*—rejects communiques and embodies communication. It epitomizes the special characteristic of consciousness: being *conscious of*, not only as intent on objects but as turned in upon itself in a Jasperian "split" consciousness as consciousness of consciousness (Freire, 2005).

In the argument of Freire (2005), liberating education consists in acts of cognition, not transferrals of information. It is a learning situation in which the cognizable object (far from being the end of the cognitive act) intermediates the cognitive actors; teacher on the one hand and students on the other. Accordingly, the practice of problem-posing education entails at the outset that the teacher-student contradiction to be resolved. Dialogical relations—indispensable to the capacity of cognitive actors to cooperate in perceiving the same cognizable object—are otherwise impossible. Freire (2005), calls for problem-posing education, which breaks with the vertical patterns characteristic of banking education, can fulfill its function as the practice of freedom only if it can overcome the above contradiction.

Through dialogue, the teacher-of-the-students and the students-of-the-teacher cease to exist and a new term emerges: teacher-student with students-teachers. The teacher is no longer merely the-one-who-teaches, but one who is himself taught in dialogue with the students, who in turn while being taught also teach. They become jointly responsible for a process in which all grow. In this process, arguments based on "authority" are no longer valid; in order to function, authority must be *on the side of freedom*, not *against* it. Here, no one teaches another, nor is anyone self-taught. People teach each other, mediated by the world, by the cognizable objects which in banking education are "owned" by the teacher.

The role of the problem-posing educator is to create; together with the students, the conditions under which knowledge at the level of the *doxa* is superseded by true knowledge, at the level of the *logos*. Whereas banking education anesthetizes and inhibits creative power, problem-posing education involves a constant unveiling of reality. The former attempts to maintain the *submersion* of consciousness; the latter strives for the *emergence* of consciousness and *critical intervention* in reality Freire (2005).

Education as the practice of freedom as opposed to education as the practice of domination, denies that man is abstract, isolated, independent, and unattached to the world; it also denies that the world exists as a reality apart from people. Authentic reflection considers neither abstract man nor the world without people, but people in their relations with the world. In these relations consciousness and world are simultaneous: consciousness neither precedes the world nor follows it. According to Freire (2005), in problem-posing education, people develop their power to perceive critically *the*

way they exist in the world with which and in which they find themselves; they come to see the world not as a static reality, but as a reality in process, in transformation. Although the dialectical relations of women and men with the world exist independently of how these relations are perceived, it is also true that the form of action they adopt is to a large extent a function of how they perceive themselves in the world. Hence, the teacher-student and the students-teachers reflect simultaneously on themselves and the world without dichotomizing this reflection from action, and thus establish an authentic form of thought and action.

Problem-posing education bases itself on creativity and stimulates true reflection and action upon reality, thereby responding to the vocation of persons as beings who are authentic only when engaged in inquiry and creative transformation. Problem-posing education affirms men and women as beings in the process of *becoming*—as unfinished, uncompleted beings in and with a likewise unfinished reality. In this incompleteness and this awareness lie the very roots of education as an exclusively human manifestation. The unfinished character of human beings and the transformational character of reality necessitate that education be an ongoing activity. Education is thus constantly remade in the praxis.

According to Freire (2005), problem-posing education is revolutionary futurity. Hence it is prophetic (and, as such, hopeful). Hence, it corresponds to the historical nature of humankind. Hence, it affirms women and men as beings who transcend themselves, who move forward and look ahead, for whom immobility represents a fatal threat, for whom looking at the past must only be a means of understanding more clearly what and who they are so that they can more wisely build the future. Hence, it identifies with the movement which engages people as beings aware of their incompleteness—an historical movement which has its point of departure, its Subjects and its objective.

Freire (2005) informs problem-posing education, as a humanist and liberating praxis, posits as fundamental that the people subjected to domination must fight for their emancipation. To that end, it enables teachers and students to become Subjects of the educational process by overcoming authoritarianism and an alienating intellectualism; it also enables people to overcome their false perception of reality. The world no longer something to be described with deceptive words—becomes the object of that transforming action by men and women which results in their humanization.

11. Conclusion

This paper having underscored the role of science and technology in national development, it is concluded that universities of science and technology are key institutions in Kenya's efforts towards good and sustainable livelihoods. Universities of science and technology in Kenya should align their courses with the aspirations of their Government with regard to science, technology and innovation. This way, these universities would achieve their seed objectives: a) the supply of indigenous technological manpower through training and retraining; (b) the development of appropriate technologies for the utilization of our agricultural and mineral resources; and (c) the sourcing of industrial raw materials.

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