THE ROLE OF UNIVERSITIES IN KNOWLEDGE-BASED INDUSTRIALISATION IN KENYA: A STUDY OF UNIVERSITY-INDUSTRY-GOVERNMENT LINKAGES IN MANUFACTURING SECTOR

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A THESIS SUBMITTED TO THE DEPARTMENT OF EDUCATIONAL MANAGEMENT, POLICY AND CURRICULUM STUDIES, SCHOOL OF EDUCATION, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN EDUCATIONAL PLANNING AND ECONOMICS OF EDUCATION OF KENYATTA UNIVERSITY

JUNE 2015
DECLARATION

I confirm that this thesis is my original work and has not been presented in any other university/institution for certification. This thesis has been complemented by referenced works duly acknowledged. Where text, data, graphics, pictures or tables have been borrowed from other works—including the Internet—, the sources are specifically accredited through referencing in accordance with anti-plagiarism regulations.

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DEDICATION

This thesis is dedicated to GOD, the eternal source of all knowledge and wisdom, for allowing me to realise how little I know, but granting me with humility the opportunity of serving HIM with what HE has revealed to me through this spiritual-academic-business proposal, the GPI, Inc. I also dedicate this work to my son Raphael who stood with me through our very difficult journey together as his only actively present member of my family.
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LIST OF ABBREVIATIONS AND ACRONYMS

AAS: African Academy of Sciences
ADEA: Association for the Development of Education in Africa
AAU: Association of African Universities
ACUP: Associacio Catalana d'Universitats Publiques
ADB: African Development Bank
AIDS: Acquired Immune Deficiency Syndrome
AIO: African Innovation Outlook
AMCOST: African Ministerial Council/Conference on Science and Technology
AOSTI: African Observatory for Science, Technology and Innovation
APEC: Asia-Pacific Economic Co-operation
ASEAN: Association of South East Asian Nations
ASTII: African Science, Technology and Innovation Indicators
ATS: African Technology Studies
AU: African Union
AUCC: Association of Universities and Colleges of Canada
BERD: Business Expenditure on Research and Development
BRDIS: Business R&D and Innovation Survey
CASTAFRICA: Conferences for the Application of S&T in Africa
CEE: Central and East European Countries
CHE: Commission for Higher Education
CIGU: Interuniversity Consortium of University Management
CIS: Community Innovation Survey
CODESRIA: Council for the Development of Social Science Research in
Africa
CPA: NEPAD’s Common Plan of Action
CSIR: Council for Scientific and Industrial Research
CUE: Commission for University Education
CYTED: Latin American Science and Technology Development Programme
DCU: Dublin City University
DRMD: Directorate for Research, Management and Development
DUI: Learning by Doing, Using and Interacting
EIS: European Innovation Scoreboard
EPZ: Export Processing Zone
ERS: Economic Recovery Strategy
EU: European Union
FDI: Foreign Direct Investment
FM: Frascati Manual
FTE: Full Time Equivalent
GATTS: General Agreement on Trade and Tariffs
GDP: Gross Domestic Product
GERD: Gross Domestic Expenditure on Research and Development
GII: Global Innovation Index
GNP: Gross National Product
GOVERD: Government Expenditure of Research and Development
GRI: Government Research Institute
HC: Head Count
HEI: Higher Education Institution
HERD: Higher Education Expenditure of Research and Development
HRST: Human Resource in Science and Technology
ICT: Information and Communication Technology
IDRC: International Development Research Centre
IEP: International Institute for Educational Planning
ILO: International Labour Organization
IMF: International Monetary Fund
IPRs: Intellectual Property Rights
ISTWG: Industrial Science and Technology Working Group
IUCEA: Inter-University Council of East Africa
KBE: Knowledge Based Economy
KNBS: Kenya National Bureau of Statistics
JKUAT: Jomo Kenyatta University of Agriculture and Technology
MDGs : Millennium Development Goals
MFP: Multi Factor Productivity
MHT: Medium to High Technology
MNCs: Multi-National Corporations
MoEST: Ministry of Education, Science and Technology
MoIED: Ministry of Industrialisation and Enterprise Development
MPND: Ministry of Devolution and National Development
MSMEs: Micro Small and Medium Enterprises
MTP: Medium Term Plan
MVA: Manufacturing Value Added
OAS: Organization of American States
OECD: Organization for Economic Co-operation and Development
OM: Oslo Manual
OST: NEPAD’s Office of Science and Technology
TT: Technology Transfer
PACE: Policies, Appropriability and Competitiveness for European Enterprises Project
PPP: Public Private Partnership
PPP: Purchasing Power Parity
PSDS: Private Sector Development Strategy
PUS: Public Understanding of Science
PUST: Pan African Union of Science and Technology

RANDFORUM: Research and Development Forum for Science-led Development
RDI: Research and Development Institute
RICYT: Network on Science and Technology Indicators-Ibero-American and Inter-American Science and Technology
RB: Resource Based
RoK: Republic of Kenya
R & D: Research and Experimental Development
RSE: Research Scientists and Engineers
SADC: Southern Africa Development Co-operation
SEIs: Strategic Emerging Industry
SEZ: Special Economic Zone

SHESHRA: Strengthening Higher Education Stakeholder Relations in Africa
SMEs: Small and Medium Enterprises
SNA: UN System of National Accounts
SSA: Sub-Saharan Africa
S&T: Science & Technology
STA: Science and Technology Activities
<table>
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<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tr>
<td>STAM:</td>
<td>UNESCO Manual for Statistics on STAs</td>
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<tr>
<td>STET:</td>
<td>Science and Technological Education and Training</td>
</tr>
<tr>
<td>STI:</td>
<td>Science, Technology and Innovation</td>
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<td>STP:</td>
<td>Science and Technology Park</td>
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<td>TFP:</td>
<td>Total Factor Productivity</td>
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<td>TG:</td>
<td>UIS Training Guide No.5</td>
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<tr>
<td>TLO:</td>
<td>Technology Licensing Office</td>
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<td>TNCs:</td>
<td>Trans-National Corporations</td>
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<td>TTIs:</td>
<td>Technical Training Institutes</td>
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<td>TTO:</td>
<td>Technology Transfer Office</td>
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<td>UIS:</td>
<td>UNESCO Institute for Statistics</td>
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<tr>
<td>UN:</td>
<td>United Nations</td>
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<tr>
<td>UNCTAD:</td>
<td>United Nations Conference on Trade and Development</td>
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<tr>
<td>UNECA:</td>
<td>United Nations Economic Commission for Africa</td>
</tr>
<tr>
<td>UNESCO:</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
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<tr>
<td>UNIDO:</td>
<td>United Nations Industrial Development Organisation</td>
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<tr>
<td>USA:</td>
<td>United States of America</td>
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<td>USTPO:</td>
<td>United States Intellectual Property Office</td>
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<tr>
<td>UN:</td>
<td>United Nations</td>
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<tr>
<td>VINNOVA:</td>
<td>Swedish Agency for Innovation Systems</td>
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<tr>
<td>WIPO:</td>
<td>World Intellectual Property Organization</td>
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<tr>
<td>WTO:</td>
<td>World Trade Organisation</td>
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The purpose of this study was to identify and document the patterns in university-industry-government linkages (UIGLs) as platforms for the commercialization of knowledge and technology in the manufacturing sector of the economy. This would be the basis for proposals to support the development of a knowledge-based manufacturing sector as envisioned in Kenya Vision 2030. To do so, the following research questions guided the study: a) What is the extent of UIGLs in the manufacturing sector? b) What is the motivation for these linkages? c) To what extent can these linkages contribute to the creation of knowledge-based manufacturing in Kenya? d) What are the challenges facing these linkages? e) How can these linkages be enhanced to facilitate knowledge-based manufacturing in Kenya? These questions were generated within the framework of Etzkowitz and Leydesdorff's (1995) Triple Helix (TH) model of an innovation system in which an entrepreneurial university is the key driver of innovation as part of a dynamic National Innovation System (NIS) constituted by UIG institutional spheres and linkages that interact closely and co-evolve as a triadic web of innovation into a knowledge-based economy. To answer the research questions, the QUAN-qual explanatory mixed methods design was used. The study targeted 49 senior university managers; 5 senior policymakers in the Ministries of Devolution and Planning, Industrialisation and Enterprise Development, and Education, Science and Technology; and 2 key manufacturing industry informants from the Kenya Private Sector Alliance (KEPSA) and Kenya Association of Manufacturers (KAM. A stratified sample of 17 university managers was selected for the UIGL survey. The AAU/AUCC Survey Questionnaire was adapted for the survey. The AU/NEPAD Community Innovation Survey Questionnaire and an interview schedule were used for an innovating manufacturing firm connected to a university. Interview schedules were used for the Director of a university-based UIGL platform and selected informants in relevant policymaking positions in the government ministries. Document analysis of policy documents on Science, Technology and Innovation (STI) and on industrialisation in Kenya was done to identify the role of the government in UIGLs. Descriptive statistics were used to describe the survey findings on the extent of UIGLs. Cross-case analysis of the interview findings and qualitative contingency analysis of policy documents were done to contextualize the survey findings. The study found that only 5 respondent universities reported having any interactions with the manufacturing sector. Of those, only 2 had UIGL platforms and university-based commercialized products on these platforms. The 2 UIGLs are only tangentially motivated by Kenya Vision 2030 policy priorities. Key challenges in creating UIGLs are: financial support for research, poor research infrastructure, limited research partnerships between universities and the manufacturing sector, and dissonance between national development and STI policies. The study concludes that there are limited UIGLs to support the transfer of knowledge and technology to the manufacturing sector, rendering the attainment of a knowledge-based manufacturing sector unlikely. Thus, study recommends the strengthening of the knowledge and technology generation and transfer system, and the prioritisation of sector-relevant research and robust partnerships for commercialisation in manufacturing in both national and institutional policy.
CHAPTER ONE
INTRODUCTION

1.0 Introduction

This chapter lays the backdrop for the study. It starts by describing the context against which to understand and appreciate the role of university-industry-government linkages in the framework of a knowledge-based economic development paradigm in general and within an industrialization agenda for Kenya. This leads to a brief examination of key global trends in that relationship. The conceptual and empirical gaps at the root of the problem are then identified and stated. The rest of the chapter proceeds to clarify the research problem by stating the study’s central research question, purpose, research objectives and specific operationalizing questions, significance, assumptions, limitations and delimitations, and the theoretical and conceptual frameworks. The chapter ends in providing operational definitions of key terms used in the study.

1.1 Background: Knowledge and Development

Man’s journey toward the ideals of human development-sustenance, self-esteem, and freedom from servitude- has been unrelenting and has been variously conceptualised and articulated. In essence, it consists of increasing the availability and widening the distribution of basic, life-sustaining goods; raising the levels of living; and expanding the range of economic and social choices available to individuals and the nation (Todaro and Smith, 2003:57). From the very simple agrarian, rural, traditional societies to the very complex, highly urbanised, industrialised nations, there is a never-ending quest for a better life in all its aspects.
To aid the attainment of these ideals, societies have organised themselves in various ways, with certain things acting as the drivers of the desired change. In largely rural, agrarian societies economic and social life revolves around land, other elements of nature and the manual effort of labour as the key sources of sustenance and wealth. In complex, industrial nations, there has been increasingly less reliance on the products of nature and more on produced capital, machinery and skilled labour (IIEP, 2007:1; Etzkowitz, 2003:7; Hernes, 2000:9). Today, the world and human development are driven by the complex forces of globalization; localisation or decentralisation; democratization; market-driven, neo-liberal economics; and secular humanism riding on the homogenizing conduits of Information and Communication Technologies (ICTs), a secular scientific epistemological system, and a relativistic, inclusive and pluralistic culturalism (World Bank, 1999).

Today more than ever before, the role of knowledge as a critical component and factor of these development drivers is vital, and has been constantly echoed in intellectual discourse on development among international development agencies, scholars, and policy-makers in both the developing and developed world. The new ‘Tower of Babel’ to aspire is a global knowledge-based society and economy. In light of the major issues of the 21st century, including but not limited to population growth, poverty alleviation, food security, scarcity of water, climate change, environmental degradation, cultural preservation, energy, among others knowledge does plays a key role in finding solutions. A powerful illustration in the overview of the 1999/2000 World Development Report puts this fact thus:

Knowledge about how to treat a simple ailment as diarrhoea has existed for centuries, yet millions of children continue to die needlessly because their parents do not know how to save them (World Bank, 1999:1).
The Report continues to observe that approaching development from a knowledge perspective can improve people's lives in a myriad of ways, giving examples of the effects of knowledge on income creation through innovation, on nutrition hence health, on how to prevent HIV and AIDS and other diseases and thus saving many from debilitating illness and premature death. Another World Bank Report illustrates other uses of knowledge (World Bank, 2002). It can help agricultural production and distribution systems become more efficient, thus increase yields and reduce waste. The utilization of modern biotechnology techniques can play a critical role in increasing yields, enhance nutritional value, improve plant characteristics and decrease post-harvest loss. It can make exports more competitive through better metrology, standards, and quality testing. Vulnerability to the effects of climate change and natural disasters can be reduced by use of new knowledge and technology in meteorology and remote sensing, thus improving forecasting and early-warning techniques (World Bank, 2002:11-12). The UN Millennium Project echoes this by emphasizing the role of scientific and technical knowledge in responding to challenges in areas such as economic productivity, agriculture, education, gender inequity, health, water, sanitation, environment, and participation in the global economy (UN Millennium Project, 2005: iii).

Knowledge is also at the heart of another critical dimension of human development, that is, economic growth. This has led to the evolution of the concept of a 'knowledge-based economy', an economy which is 'directly based on the production, distribution and use of knowledge and information' (OECD, 1996: 7). A knowledge-based economy relies primarily on the use of ideas and attributes inherent in human capital rather than in mere physical abilities and on the application of technology rather than the mere extraction of raw materials or the exploitation of cheap labour
(World Bank, 2003:1). It is an economy in which knowledge is created, acquired, transmitted, and used more effectively by individuals, enterprises, organizations, and communities to promote economic and social development. In a closing address to participants in an IIEP workshop, the Director made this observation:

*The material basis of human welfare will...result from the capacity of a population to develop new knowledge and apply new technology. The content of knowledge increases in everything man makes. Less and less is nature’s own, pure and unadulterated. The destiny of a society will depend less and less on nature’s gifts and depend more and more on the trained talents of its people (IIEP, 2000:8).*

A World Bank Report also observes:

*Knowledge is increasingly at the heart of a country's comparative advantage, an advantage which is less and less from abundant natural resources or cheap labour and increasingly from technical innovation and the competitive use of knowledge or from a combination of the two (World Bank, 2002:8).*

Using a typology by Lundvall and Johnson (1994), this knowledge takes the codified form of *know-what* (facts), *know-why* (scientific knowledge of principles and laws of nature, *know-how* (skills), and *know-who* or socially embedded knowledge (who knows what, who knows how to do what) (OECD, 1996:12). There is also knowledge in the form of skills needed to handle codified knowledge, referred to as tacit knowledge that is acquired through learning. Technology is embodied knowledge in artefacts (products, processes, services) resulting from applied research, development and such related activities as design, testing, production engineering, quality control in academic, research, technical or business institutions (Mwamadzingo, 1996:14).

The measurement of knowledge in the knowledge-based economy revolves around the measurement of knowledge inputs, stocks and flows, outputs, networks and learning (OECD, 1996:31). Knowledge inputs have been measured through
expenditures on Research and Development (R&D), employment of engineers and technical personnel, patents, and international balances of payments for technology. Knowledge **stocks** take the form of R&D inputs, stocks of R&D personnel and patent stocks. Their measurement focuses on measurement of R&D stock relative to production, on annual increases in researchers in various fields, in both instances taking into depreciation into consideration, and on use and expiration periods of exclusive rights for patents. Two proxy indicators used to measure the **flow** of knowledge are embodied and disembodied diffusion, the former entailing the introduction of machinery, equipment and components that incorporate new technology into production processes, and the latter with the transmission of knowledge, technical expertise or technology in the form of patents, licences and know-how. Knowledge **outputs** have been measured through categorisation of industrial sectors or parts of the workforce as more or less intensive in R&D, knowledge or information such that, say the manufacturing sectors can referred to as high-, medium-high, medium-low, or low-tech in R&D intensity (ratio of R&D expenditures to gross output). The measurement of **learning**, in effect the measurement of a learning economy, uses traditional indicators such as the years of education, experience, and more recently the private and social rates of return to investment in education and training (OECD, 1996:41). In a critique of this classification, West (2012:4) points out that there is need to include measures of **outcomes** through a study of the manner in which these ends are reached say by looking at the expenditure-revenue relationships.
OECD (1996:39) and Nordfors, Sandred, and Wessner (2003:42) note that current knowledge indicators which are primarily measures of knowledge inputs and flows are not adequate to describe knowledge development and distribution. This essentially involves measurement of the ability of countries and systems to distribute knowledge among different actors and institutions. This limitation takes on significance when it is borne in mind that knowledge by itself does not transform economies but yield its greatest benefits when used within a system of institutions and practices referred to a national innovation system, NIS or national system of innovation, NSI (World Bank, 2002:24). This is 'a web' made up of macroeconomic and regulatory framework, including policies that affect technology diffusion; market conditions that favour innovation; innovative firms and networks of enterprises; knowledge-producing organisations in the education and training system; access to the global knowledge base; adequate communication infrastructures among other factors (World Bank, 2002:24; Gault, 2010:8,20-32; Metcalfe, 1995). This is a more fruitful approach because it draws attention to the continuum of activities involved in innovation, right from its generation to its introduction to economic and social processes.

Current efforts to measure knowledge networks focus on indicators of the innovation process and distribution of knowledge among key actors and institutions in the economy (OECD, 1996:39-41; Gault, 2010:21-27). Those directed at the measurement of the innovation process are proceeding through innovation surveys of individual firms, such as the OECD-driven Community Innovation Survey (CIS), the Policies, Appropriability and Competitiveness for European Enterprises Project (PACE), the US Business R&D and Innovation Survey (BRDIS), and the Canadian
Advanced Technology Survey (ATS). In Africa, initiatives that have adopted OECD’s tools include the African Science, Technology & Innovation (ASTII) initiative launched in 2007 in Mozambique which came after the New Partnership for Africa’s Development (NEPAD)-sponsored African Ministerial Conference on Science and Technology (AMCOST 1) of November 2003, and which uses the European Union (EU)’s CIS (2006) tools (NEPAD, 2005:5).

The measurement of the **knowledge distribution power** of economies is being done through analysing two flows: distribution of knowledge among universities, public research institutions, and industry and the distribution of knowledge within a market between suppliers and users. The first of these efforts focuses on the development of indicators of interactions between government, productive sector and academic actors so as to measure the institutional capabilities to transfer knowledge. These indicators include co-operative research projects, research centres, co-patenting and publishing, personnel mobility, and access to research findings (OECD, 1996:41). Ultimately, of course, the desired outcome of all these efforts is innovation, that is, knowledge in embodied use in the form of people, goods, services and processes in the economy and society.

In this study, innovation is only considered to occur in part when knowledge and technology are commercialised thus transferred in application, when they become or can potentially be embodied in manufactured goods and introduced into the market, in which case it is considered to contribute to the creation of a knowledge-based manufacturing economy (Gault, 2010:38-43, 117; Gulbrandsen and Rasmussen, 2008; OECD, 2005:46-47). Thus, for the purposes of this study, the interest is in the
‘indicators of commercialisation of knowledge and technology’, the indicators for getting knowledge and technology into innovative economic products that translate into additional output that expands economic growth’ (Lehming in Nordfors, Sandred and Wessner, 2003:42). These include: publications, patents, licenses, spin-offs and other organisational arrangements, income streams, the ability to attract venture capital and the ability to attract research funds that would not otherwise have materialized. It is these indices that are the interest of this study. Equally important are the **indicators of a knowledge-based economy**. OECD indicators include: overall R&D intensity (GERD), government expenditure on R&D (GOVERD), higher education expenditure on R&D (HERD), business enterprise expenditure on R&D (BERD) as a percentage of Gross Domestic Product (GDP), ICT expenditure as a percent of GDP, high-tech patents per capita, number of knowledge-intensive companies, and employment in high-tech services (Nordfors, Sandred and Wessner, 2003:11).

The creation of knowledge-based societies and economies relies very significantly on the capacity to acquire, use and transmit knowledge (Hernes, 2000:8; OECD, 2005:87). This underscores the central role of the science system, especially research institutes and universities. This role has received a lot of attention in international discourse within global development agencies especially at the World Bank, United Nations Educational Scientific and Cultural Organization (UNESCO), and the International Development Research Centre (IDRC); in regional development networks such as OECD, NEPAD; in many advanced and developing countries; and among scholars and policymakers (Nordfors, Sandred and Wessner, 2003:9). For example, the World Bank has reflected the university subsector’s importance in four
Reports (World Bank 1994, 2000, 2002, 2009). In a knowledge-based economy, OECD (1996:21-27) singles out three functions that the university plays as part of the science system in the knowledge continuum: knowledge production, knowledge transmission, and knowledge transfer. With regard to knowledge production, universities are primary producers of new knowledge through basic and applied research, scientific and technological knowledge. Universities also play a key role in knowledge transmission through the education and training of scientists and engineers for the knowledge-based economy. Finally, they play an important role in transferring or diffusing knowledge throughout the economy to economic and social actors through university-industry-government linkages, or in Etzkowitz words, the 'capitalization of knowledge' (Etzkowitz, 2004:66). In the words of Benner (cited in Goransson and Brundenius, 2012: 21) universities are increasingly becoming the most important national instruments for securing a position in the globalized knowledge-based economy by securing scientific visibility and by fostering networks of innovators and innovating sectors around them.

Litan, Mitchell and Reedy (2007:8) observe that universities have a 'range of outputs such as information, materials, equipment and instruments, prototypes, networks and human capital'. They go on to point out the various mechanisms through which these outputs are diffused, including: publications, conferences, informal exchanges, patents, licenses, non-patent innovations, start-up companies and consulting arrangements. Further, commercialization paths have been charted. At the Dublin City University, DCU, the transfer template developed by an in-house university firm, Invent, is shown in Figure 1.1:
Publication of Results

Research
Research Grants
Collaborative
Research Contract

Invention disclosure
From faculty, Staff

Initial Technology Assessment
Patent & Literature Search
Technology & Market
Assessments IP Committee

Commercialization Support Programmes
Technology Scale-up/Proof-of-Concept
In-depth Technology & Market -Related R&D
IP Protection

Inventor Led Commercialization
Technology & Market Evaluation
IP Protection
Technology Marketing

Licensing Options

University Led Commercialization
Technology & Market Evaluation
IP Protection

Spin-Off Company Formation

Direct Licence to

Direct Licence to an Existing company

Figure 1.1: Commercialization pathway at Dublin City University

Source: DCU, 2001, p.17
Of particular interest to this study are the more formal institutional mechanisms within the university through which commercialization of knowledge and technology is made possible. This is for two reasons. Firstly, as Baiya (2013) observes, the 'capitalization of the innovation helps to create an innovation bridge, therefore increasing the process of making the idea successful' and adds that this is the reason why 'innovation and business incubation centres are critical to the growth of an innovation culture and country'. Secondly, such a focus has the potential of facilitating observation and measurement of variables that are central to this study. Gulbrandsen and Rasmussen (2008:4) point at the difficulty in identifying appropriate measures of commercialization especially in recognition that 'there is no standardized method for acquiring data on commercialization' as happens through national R&D statistics or guided in such statistical manuals as the Frascati Manual (FM) on measurement of R&D and Oslo Manual (OM) measurement of innovation in enterprises. The authors also note that these indicators 'have neither been much developed or used' (Gulbrandsen and Rasmussen, 2008:7).

Universities all over the world have developed various structures to facilitate commercialization of knowledge, such as the liaison office, Technology Transfer Office (TTO), the technology incubator, and firm formation in the form of a start-up or spin-off company, whether situated in a science or technology park (Baiya, 2013; Mathieu, 2011; Gulbrandsen and Rasmussen, 2008:2-3; Etzkowitz, 2004:72-73, etc). In the context of the entrepreneurial university, Etzkowitz (2004:73) identifies iterative movement among the research group, liaison office, technology transfer office and the incubator as hybrid organizations. Liaison offices 'facilitate contacts and formalise the process by which firms often make their contacts through former
students and personal connections’. He further defines a technology transfer office as a ‘search mechanism that identifies, patents, markets and licenses IP as ways of ‘pulling out knowledge encapsulated in a technology out of university research groups and finding a place for it’. Firm formation from academic research has come through pitching through the venture capital firm providing external support structure for firm formation projects’ and through the incubator, a ‘formal organisation providing space and other assistance to nascent firms emanating from academic research’. However, as Litan, Mitchell and Reedy (2007:8) and Brundenius and Goransson (2012: 351) caution, the issues of ‘transfer mechanisms and the societal measures for benefit in terms of diffusion of innovation within the market place’ require further investigation in both developing and developed countries.

To realise the knowledge-based economy, there is need for integrative mechanisms and transformations within the NIS in order to enhance the commercialisation of the knowledge outputs of the university into the economy. This is especially critical in the background of globalised markets, world-wide interconnected new communication infrastructures and technologies, the increasingly complex nature of necessary knowledge, developments that are increasingly calling for co-operation on the part of innovation actors, and the precarious situation in innovation capabilities in many developing countries that have deficient innovation systems. This also reflects the growing understanding that innovation is more organisational rather than strictly technological, its complexity as a non-linear phenomenon and requires new configurations of interactions and the internal transformation of traditional institutions (Etzkowitz and Dzisah, 2008:8; Etzkowitz and Leydesdorff (1997).
The Millennium Development Project’s Task Force on Science, Technology and Innovation (STI) delineates the frontiers of transformation in the policy environment. The key areas of policy action include focusing on platform technologies such as ICT, bio- and Nano-technology; improving infrastructure services as a foundation for technology; improving higher education in science and engineering and redefining the role of universities; promoting business activities in science, technology and innovation; improving the policy environment; and focusing on underfunded research for development (UN Millennium Project, 2005:1). Etzkowitz (2004: 64) argues that the university must evolve to become ‘entrepreneurial’ in order to play its transformative role in the creation of a knowledge-based society. The enterprises that make up the manufacturing industry are the essence and drivers of development because that is where the bulk of production essentially occurs (IDRC, 1991:2; Gault, 2010: 11). These enterprises need to enhance their technological capacities to create new products and improve existing ones, outputs that need to be globally competitive. They must also be ready to partner with sources of commercializable knowledge and technology. A precise summary of the respective roles of the three actors is provided by ACUP (2013:44-6; 50-52; 54-55) as well as in the dictum ‘Entrepreneurial university, Engaged industry, and Active government’.

Within the commercialization imperative, how the co-evolution and transformative dynamics play out in both developing and developed countries, whether the university through the interface structures described earlier is the key driver in the innovation processes, its relationship of this to the manufacturing sector and the role of government is a nascent subject in empirical literature. Gulbrandsen and Rasmussen (2008:2) observe that many countries are undergoing through reforms to accelerate
the commercialization of research results through 'changes in the academic system, instruments for research funding and establishment of structures and schemes to support commercialization activities.' They cite the famous Bayh-Dole Act in the US and more recent policy changes that 'stress the expectations that universities could contribute more directly to industrial development'. To the US, they add examples of UK, Denmark, France, and Japan where policy changes are geared to giving the universities 'incentives to support and build an infrastructure for the commercialization of research' such as TTOs. In Norway no similar legislative changes have been augmented with interest among policy-makers and ministries in indicators of commercialization.

University-Industry-Government Linkages and Development of a Knowledge-based Economy in Kenya

There are numerous development challenges to which efforts by various stakeholders have been and continue to respond to in Kenya since independence. At independence, they formed the trio of ignorance, disease and poverty as articulated in Sessional Paper No. 10 (RoK, 1965:1). This list has been re-phrased severally as times and experience have changed, but essentially include food insecurity, adverse weather and recurring droughts, scarcity of water, environmental degradation, new diseases, corruption and poor governance, weak community-based institutions, under-exploitation of some natural resources among others, leading to poverty, low life expectancy and a general low quality of life (RoK; 2006:250-1).

Since the country became politically independent, the Government of Kenya has responded to these challenges in various ways since independence with various

Over the years, the Government of Kenya has consistently earmarked the development of the industrial sector since independence. The key landmarks in this endeavour include: ownership of the economy at independence, promotion of import-substitution industries through government ownership of industries, linkage to domestic raw materials for employment generation and poverty alleviation, export orientation to bolster foreign exchange earnings, price competitiveness for regional markets, and concerns for comparative advantage in the context of globalisation (Kibua, 2007: 8; Ronge and Nyagito, 2000:1-9). The two major strategies through which these endeavours have been undertaken are import-substitution industrialisation (1963-1989) and export-oriented industrialisation (1989-date). In 1997, the Government through a Sessional Paper, put industrialisation as a lead engine for development (RoK, 1997). The push was initially to be driven by selected labour-intensive, resource-based (RB) and light manufacturing industries, primarily small-scale industries that use locally available raw materials and simple labour-intensive
technologies and are therefore capable of generating employment (RoK, 1997:38-44). Notable examples are agro-based industries like: textiles; horticultural processing; skins, hides and leather; tea, coffee and sugar processing; and building and construction, such as brick manufacturing. The second phase was to target intermediate and capital goods industries that are more technology and capital intensive. These were to include metallurgical, non-petroleum-based chemical, petrochemical, pharmaceutical, and machinery and capital goods industries (RoK, 1997:44-47). The latter were initially expected to produce for the domestic market with the export market being their eventual goal. This approach was largely maintained in the subsequent policy framework, the ERS (RoK, 2003:34-36) but altered in the current development blueprint, the Kenya Vision 2030 (RoK, 2007:60-65).

The key argument for industrialising the Kenyan economy is best captured in Kenya's first emphatic policy blueprint on industrialisation, *Sessional Paper No. 2 on Industrial Transformation to the Year 2020* (RoK, 1996:2-3). This policy statement is formulated in the context of poverty, unemployment, meagre foreign exchange earnings from primary commodity exports, falling real wages, population pressure on land and attendant decrease in agricultural productivity. Citing the experience of the Newly Industrialized Countries (NICs), the government sees industrialisation as the vehicle of achieving rapid and sustained economic growth and structural transformation through the utilisation of the full potential of the country's resources to broaden the economy. The engines of this strategy are efficient industries that are internationally competitive and which utilize the latest technology. The emphasis on
industrialisation in Kenya is also echoed in the Kenya Vision 2030 in which a part of the destiny is ‘a rapidly industrialising middle-income nation’ (RoK, 2007: ii).

Ronge and Nyagito (2000:1) citing Wagacha and Ngugi (1998) point out that although under United Nations classification, the industrial sector includes four divisions (mining, manufacturing, building and construction, and public utilities), manufacturing dominates, with formal sector manufacturing constituting about 73% of the total industrial sector output between 1983 and 1997. Lall and Kraemer-Mbula (2005:5-7) emphasize the role of manufacturing as ‘the main engine of structural transformation’ and outline ten reasons why it is important.

Manufacturing industry is the main vehicle for application of technological progress to production. Manufacturing is the major source of innovation and the hub for diffusing innovation to other activities. The sub-sector is a vital source of new skills and attitudes particularly in transforming traditional economic structures. Innovation and skill creation by manufacturing have large beneficial externalities for other activities. It also provides the direct demand stimulus for the growth of many modern services. It leads to the development of modern institutions and legal structures that the modern economy requires. It is also the main source of dynamic comparative advantage through the shift from primary to more advanced, high value manufactured exports. The internationalization of the economy often follows the spread of manufacturing. The exposure to foreign markets, enterprises, skills and practices that manufacturing brings can be the catalyst for modernisation of national industrial enterprises. Further, for purposes of measurement of the national technological capacity, this sub-sector has a key role in the measurement of technological and skill
intensity through the value-addition process, which also serves as a proxy measure of the knowledge composition of both the process and final manufactured goods. These measures are also important for determining quality and international competitiveness of the manufactured output.

This study examines the prospects of developing a knowledge-based manufacturing sub-sector in Kenya. As already pointed out, the development of a knowledge-based economy significantly depends on the creation and distribution of knowledge among key actors and institutions. The key question is whether there exist such knowledge networks for the creation of a knowledge-based manufacturing in Kenya and if so their extent and impact. As earlier noted, these networks are facilitated by such hybrid university-industry-government platforms as Industrial Liaison Offices (ILOs), TTOs, incubators, science/technology/industrial parks (STPs), Special Economic Zones (SEZs), and other industrial clusters to mention a few. The second aspect of that is whether there is evidence of co-evolution in these institutional spheres that enables the creation of a knowledge-based manufacturing sector.

From a policy perspective, two themes that seem to signal government commitment to the development of a knowledge-based economy need to be highlighted: the emphasis on the development of private enterprise through Public-Private-Partnerships (PPPs) and the development of an STI system. The emphasis on the role of the private sector in development led to the formulation of the Private Sector Development Strategy, PSDS 2006-2010 (RoK, 2006) that aimed at enhancing the sector’s growth and competitiveness and hence its contribution to wealth and employment creation. Important pillars of this intervention include: improvement of the business
environment, acceleration of institutional transformation, expansion of trade, improvement of the productivity of enterprises, and support for entrepreneurship and indigenous enterprise development (RoK, 2006: 6-7). In particular, there was an emphasis on improving the productivity of enterprises and support for entrepreneurship and indigenous enterprise development. Improvement of enterprise development was to be done through the enhancement of labour and capital productivity, stimulation of R&D activities, and adoption of modern and appropriate technology. Support for entrepreneurship was to be achieved through the development of new enterprises, facilitation of the graduation and evolution of enterprises, and enhanced firm-to-firm linkages (RoK, 2006: 10-11).

This is significant for this study because of the linkages implications for research, technology development, access to appropriate human resources, and enhanced public-private sector partnerships particularly for the development of an indigenous industrial base driven by Micro, Small and Medium Enterprises, MSMEs. The Kenyan context is characterized by the dual nature of the economy in general and within the manufacturing sector in particular whereby the modern and traditional as well as the formal and informal manufacturing sectors exist side by side. The formal manufacturing sector consists largely of Multi-National Corporations (MNCs), large firms owned by foreigners, and some medium-size ones owned by both locals and Asians. The largest component of the manufacturing sector especially on the basis of size rather than output or quality is the informal sector that is owned by locals and which is largely composed of micro and small enterprises. Any chances of building an indigenous industrial base that is sustainable and which can aid in the attainment of Kenya’s long-term development objectives lies in the development of this sector.
Since the 1972 International Labour Organisation Report, there has been growing recognition among policy-makers and scholars that the informal sector needs tremendous support in order that the MSEs in manufacturing grow and graduate (ILO, 1972; RoK, 1992, 2005; McCormick and Kinyanjui, 1994; McCormick, 1992; Mullei, 2003; Kimuyu, 2004; Akoten, 2006; 2007 a & b; King, 2005; Laichena and Kobia, 2006; etc).

The PSDS lists some of the strategic actions to be pursued. They included developing labour productivity schemes through skills development, strengthening of linkages among research institutions and industry, support for protection of IP and innovations, encouraging adoption of modern and appropriate technology by MSMEs to enhance productivity gains, support for capacity building of incubator programmes and youth empowerment programmes and support for business skills upgrading for MSMEs to increase the number of businesses with trained personnel.

The other theme in Kenya’s development and economic growth discourse is knowledge-led development and the related concepts of a knowledge economy and society. This is clearly articulated in Kenya Vision 2030 in which STI and human resource development are recognised as foundations of the development framework due to the influence on total factor productivity and efficiency and as pre-requisites for a rapidly industrialising economy (RoK, 2007:viii). The development blueprint links the exploitation of knowledge to STI and to the creation of a knowledge-led economy as illustrated in the experiences of countries such as South Korea, Malaysia, Finland, Ireland, Chile and China (RoK, 2007:19). To promote STI, the Government proposes to strengthen technical capabilities, develop highly skilled human resources,
intensify innovation in priority sectors, and enhance STI awareness (RoK, 2007:19-20). To promote human resource development, interventions include learning within employment which includes on-the-job training; specialised training of talent; identification and attraction of top Kenyan expertise abroad; harnessing retired high cadre talent; strengthening linkages between industry, Technical Training Institutes (TTIs), and research institutions; and re-orientation of human resources to the requirements of enterprises (RoK, 2007: 22-23). This is also the dominant theme in the Kabiru Report (RoK, 2006) published just a year before the Kenya Vision 2030.

However, in spite of these developments, numerous Government policy appraisals and empirical studies on the manufacturing sector in Kenya acknowledge the poor performance of the sector in terms of contribution to national output, averaging less than 10 percent in two decades (McCormick, 1995:183; Kimuyu, 1999:165; Ikiara, Olewe-Nyunya, and Odhiambo, 2004:205; Ng’ethe and Ngome, 2006:3; Kibua, 2007:1; RoK, 1997:1; AfDB, 2014:1; 31-37). This lack-lustre performance is attributed to several factors, exogenous and also endogenous. Oil shocks, adverse terms of trade, fluctuations in global demand are some of the exogenous ones. A poor policy environment, the ‘missing’ middle’ of sufficient indigenous SMEs in the industrial structure, a weak technological base, a dearth of a critical pool of skilled workers, an uncoordinated human resource development policy, a nascent STI awareness in policy-making circles and low demand for locally produced goods are some of the internal factors (Ng’ethe and Ndua, 1992:1-4; Akoten, 2006 a & b, 2007). Ongile (1995) and Kibua (2007:36) have even questioned the strategic value of the pursuit of manufacturing-led development in light of this, with Kibua proposing a
service-sector led development strategy instead. The role of non-economic variables has also been acknowledged.

Of particular concern is a critical gap in the monitoring of policy interventions with regard to the actual creation of a manufacturing sector that is knowledge-based. In spite of available and growing literature globally on innovation metrics and the types of knowledge sector-productive sector-policy configurations that enhance knowledge-driven and knowledge-based economic growth, there is a dearth of such studies on Kenya. Those available do so from dyadic or bilateral relations between two institutional spheres rather than a triadic approach that underpins the Triple Helix. Few of such studies focus on the general interactions between the knowledge base and industry. They fail to include the role of the policy and structural environment in knowledge transfer and the impact on innovation (Odhiambo, 1996, Commission for Higher Education, 2000).

Mwamadzingo (1996) examines the general interactions between universities and industry on S&T in the manufacturing sector using the University of Nairobi as the case university but with only a tangential focus on the role of government in these interactions, with no mention of knowledge-based manufacturing, of the co-evolution of institutional spheres, or of commercialization of knowledge outputs and outcomes. His recommendation, though, is that in as much as the potential of co-operation between academic institutions and the productive sector exists, this can be effectively exploited with the incorporation of explicit policy support from the larger macro-economic context, the involvement of other relevant institutions and the formation of bridging institutions (Mwamadzingo, 1996:202-5).
Although Ng’ethe and Ngome (2006) also studied university-industry linkages at the JKUAT, they did not focus much on the role of government in these interactions, did not focus on commercialization of knowledge and technology except by way of a recommendation, and neither did they ask whether these interactions help create a knowledge-based manufacturing. Laichena and Kobia (2006) conceptually argue that universities can spur the growth of MSEs in the context of MDGs, while Munyoki, Kibera and Ogutu (2011) examine the extent to which such linkages exist with a focus on medium and large manufacturing firms but with no mention of the role of government, of the linkage platforms that facilitate knowledge and technology transfer, of the commercialization of university knowledge outputs or of whether these enhance the creation of knowledge-based manufacturing. Ondimu (2012) comes very close to the subject in a concept paper on possible approaches to commercialisable university research in Kenya in which the UIGL approach is described. However the focus of the paper is not on the creation of knowledge-based manufacturing and the application of the triple helix.

Thus, there is therefore a dearth of empirical studies that clearly conceive these linkages within the context of a university-driven NIS involving the knowledge or science base, the manufacturing industry and the policy environment and that also address the co-evolution of these spheres. There are no specific studies that conceive of such linkages within the context of commercialization platforms and pathways. There are also no studies that examine the extent to which a knowledge-based manufacturing sector of the Kenyan economy is being realized, and on what challenges lie on the path of the establishment of such an economy. These constituted the conceptual and empirical gaps at the root of this research study.
1.2 Statement of the Problem

There is tremendous potential in Kenya for the development of a vibrant knowledge-based manufacturing sector for output diversification, wealth creation, increased export earnings, employment creation and poverty alleviation. This calls for a manufacturing sector that supports the production of high quality and competitive products in highly efficient settings, a differentiated consumer focus, and an awareness of a competitive international environment. It also calls for a manufacturing sector that places a premium on a highly skilled labour force and a strong technological base, supported by a supportive structural environment.

From the background, it is evident that UIGL platforms for commercialization of knowledge and technology in providing for the development of a knowledge-based manufacturing sub-sector have tremendous potential. However, in Kenya there is lack of both conceptual and empirical studies on the extent to which UIGL platforms exist and on their role in the manufacturing sector in driving both academic and policy debate and in setting the agenda for knowledge-based industrialization. The extent to which indicators of knowledge and technology creation and diffusion have developed in the Kenyan industrialization and STI discourse to support policy learning through monitoring, benchmarking, evaluation and foresight is not clear. This is especially critical with regard to the measurement of institutional capabilities to transfer knowledge among actors and institutions since these are the framework upon which monitoring of the evolution of a knowledge-based economy can be done. Clearly, there is need to develop an industrial sector-based NIS measurement framework that is based on the comprehensive web of knowledge production-transfer-application-support structures in a web of interactions in the MSEs, SMEs and MNCs within the
manufacturing sub-sector. Systematic studies should identify the extent, types, dynamics and impacts of such linkages within this sector especially with the objective of gauging the extent of university-driven knowledge and technology diffusion so as to institute and entrench the development of a knowledge-based manufacturing sector in Kenya.

The central focus of this study was to find answers to the following fundamental questions, namely: within Kenya’s industrialisation policy as currently conceived in the Kenya Vision 2030 as driven by STI, what is the configuration of UIGLs as platforms for the transfer of knowledge and technology to the manufacturing sector of the economy? Does such a configuration enhance or retard the development of a knowledge-based manufacturing sub-sector? Are there any indications of a co-evolution in the configuration’s NIS institutional spheres that hold promise of development of a knowledge-based economy in general and a knowledge-based manufacturing sector in particular? If not, what are the challenges and how can these be addressed?

1.3 Purpose of the Study

The purpose of this study was therefore to examine the contribution of universities in Kenya to the country’s industrialization agenda through UIGLs in the manufacturing sub-sector of the economy. This would form the basis of making relevant recommendations on a relevant configuration of the UIGLs that would facilitate the development of a robust, sustainable knowledge-based manufacturing sector.
1.4 Objectives of the Study

This study was guided by the following objectives: to

i. Examine the extent to which the entrepreneurial concept exists in universities in Kenya with specific application in the manufacturing sector of the economy;

ii. Analyse the motivations for the creation of linkages between universities, the manufacturing industry, and the government in the context of knowledge-based industrialization;

iii. Examine the extent to which these linkages can contribute to the attainment of knowledge-based industrialization in Kenya;

iv. Identify the challenges facing the development of these linkages;

v. Suggest interventions to be instituted to enhance the potential of the linkages to promote the development of knowledge-based industrialization in Kenya.

1.5 Research Questions

The following research questions guided the study:

i. To what extent do University-Industry-Government Linkages (UIGLs) exist in the manufacturing industry in Kenya?

ii. To what extent are the UIGLs related to the development of a knowledge-based manufacturing sector in Kenya as envisioned in the Kenya Vision 2030?

iii. To what extent does co-evolution of institutional spheres in the identified UIGLs exist to support the emergence of knowledge-based manufacturing in Kenya?

iv. What are the challenges to strengthening UIGLs in the manufacturing sector of the Kenyan economy?

v. What support services are needed to enhance UIGLs for the development of knowledge-based manufacturing in Kenya?
1.6 **Significance of the Study**

Kenya is currently pursuing its national development imperatives under the Kenya Vision 2030 framework. Confronted with a myriad of human development challenges, the government recognizes that social, economic and political development must be a national priority and this is reflected in the Vision’s pillars and their foundations. Two of the foundations are of particular importance for this study: STI and human resource development (RoK, 2007:19, 21). The government recognises the role of STI in the creation of a knowledge-based economy for rapid growth and international competitiveness. It also recognises the critical importance of a pool of high quality and adequate human resource with technical, industrial and entrepreneurial competencies to support a knowledge-based development process. Finally, and most fundamentally, there is the ultimate expectation that Kenya will grow into a rapidly industrialising economy, hence underscoring the role of the manufacturing sector as the essence of industrialisation. This is captured in the inclusion of manufacturing as part of the Economic Pillar.

This study therefore hoped to provide empirical insights into the relationships between these policy intentions and their actual evolution in the economic scene, in particular the innovation-manufacturing nexus. These insights were geared to providing the empirical basis for continual evaluation of the relationship between national development policy, the development of higher education and economic growth, and the testing ground of newer theoretical insights on the emergence and entrenchment of knowledge-based economies in a developing country scenario as postulated in the Triple Helix approach.
Further, this study will also be useful to policymakers in national and sectoral development policy dockets who are interested in the creation of a knowledge-based economy and society, particularly those situated in the country’s innovation system. The study hopes to illustrate the workings of the country’s innovation system by operationalising it in the manufacturing sector. This will also aid in the development of an indigenous innovation measurement framework for assessing the extent to which the development of a knowledge-based manufacturing sector is evolving.

Moreover, university managers who are at the heart of the science and technology system that provides the knowledge and technology to drive the knowledge-based industrial sector, are another set of key beneficiaries. The predominant culture where the commercial potential of research findings is rarely explored needs to change through the setting platforms for such exploration and exploitation. This has the capacity to create a vibrant research culture from which the other missions of the university are rejuvenated and could provide another stream of income and resources to improve the quality and relevance of universities.

Finally, stakeholders in the manufacturing sector stand to benefit from the creation of a business environment that spurs further growth frontiers through diverse and internationally competitive products. Medium to high technology-based products constitute the bulk of exports in developed, industrialized and newly industrialized countries. Thus the growth of the knowledge and technology components of their products places manufacturing firms on a more competitive platform than low technology ones, raising their international profiles and profitability. This study offers insights into how these key stakeholders can engage more actively with the
knowledge sphere and into how to lobby policy makers for relevant forms of policy support.

1.7 Limitations of the Study

The following were some of the following constraints:

a. The absence of records on interactions between university staff and the productive sector and what role the government plays in these interactions. Although academic staff are instrumental in knowledge creation and diffusion, mechanisms to track their activities in commercialization or to encourage self-report of such activities are largely absent in respondent universities in Kenya.

b. The absence of data within universities on university-based knowledge outputs such as patent applications, applications for licenses, especially with regard to manufacturing.

In order to address these limitations, the researcher relied on multiple sources of information on university innovation activities from engaging with stakeholders with convergent information such as the Commission for University Education (CUE), the DRMD, KIRDI and the MoIED.

1.8 Delimitations of the Study

The study focused on universities as the key part of the science system and did not focus on other research institutions based on the fact that universities have a broad mandate to teach, conduct research and be involved in influencing their environments through outreach such as through knowledge and technology transfer to the economy. The study also confined itself to UIGLs originating from the university as these were key indicators of the universities' entrepreneurial behaviour. These UIGLs also
precluded bilateral relations between the university and industry or university and government and focused on triadic or triple helix interactions.

The study also conducted a survey as the key means through which to provide a general picture of the university-based entrepreneurialism in Kenya. The researcher also used interviews to solicit information from the key policymakers in the STI and industrialization departments of government in order to gain in-depth insights on how knowledge, technology and innovation are being mainstreamed in economic management.

The researcher did not address the teaching role of universities through which manpower is developed but instead focused on the transfer of knowledge and technology.

Finally, the study limited itself to the assessment of the efficacy of the NIS in the manufacturing sector within the First Medium Term Plan period (2008-2012) in the implementation of the Kenya Vision 2030.

1.9 Assumptions of the Study

The study took for granted that university managers and development policymakers appreciate the place of knowledge in development and that they recognize the role of manufacturing in economic development; that universities in Kenya appreciate the place of entrepreneurialism in enhancing the contribution of the university to development; and that the existing indicators of national innovation systems will be applicable to a study of innovation and innovation systems in the manufacturing sector of the economy in Kenya.
1.10 Theoretical Framework

The central relationship explored in this research study is that between knowledge, technology, economic growth and development policy. The study adopted the Triple Helix Theory, a non-linear system-based innovation approach that emerged from a confluence between Henry Etzkowitz's interest in the study of university-industry linkages and Loet Leydesdorff's interest in an evolutionary model that can generate an overlay of communications (Etzkowitz and Leydesdorff, 1995; Etzkowitz and Leydesdorff, 2000:109; Etzkowitz, 2002:2). This approach states that the university can play a leading role in innovation and the creation of a knowledge-based society due to its comparative advantage as a knowledge institution. The fundamental proposition of the theory is that innovation is the outcome of linkage networks or 'multiple reciprocal relationships' among universities, industries and governments. These three actors form the three spheres of the Triple Helix. There are three dimensions of the model representing interlocking dynamics: internal transformation in each of the helices; the influence of one helice upon another; and the creation of a new overlay of trilateral networks and hybrid organisations at the interfaces from the interaction of these helices formed for the purpose of innovation (Etzkowitz, 2002:2; Etzkowitz, 2013:8).

Internal transformation in each of the spheres can be illustrated in the university sphere, which incorporates an entrepreneurial orientation into its mission (Guerrero and Urbano, 2013: 11; Mathieu, 2013:18; Etzkowitz, 2013:21; Etzkowitz, 2004:64). Etzkowitz (2013:22-23; 2004: 70-74) traces the development of academic entrepreneurship as the university moved from being a 'conservator of knowledge to an originator of knowledge', from an institution for 'conserving and transmitting
knowledge' into an institution in which 'knowledge is also created and put into use'.
This is not a linear process either expressed as 'market pull' or 'technology-push', but
an interactive one in which there is a back-and-forth movement 'starting from
research to utilisation and reverse from problems in industry and society and seeking
illustrates this intentional and links-driven entrepreneurial process within the
university structures of knowledge and technology transfer, starting from liaison
offices, technology transfer offices, and firm formation by entrepreneurs. Thus this
'capitalisation of knowledge' becomes the basis for economic and social
development, thus the university's enhanced role'.

On the part of government, there is a development policy shift from an industrial
economy that 'reflects the predominant production factors of capital and unskilled
labour' to an entrepreneurial one in which 'the dominant factor is knowledge capital
as a source of competitive advantage, complemented by entrepreneurship capital
representing the capacity to engage in and generate entrepreneurial activity' (Guerrero
and Urbano, 2013:11). The authors, citing Porter, et al (2012) summarise the
transition as movement from a factor- to efficiency- to innovation-driven economy.
Firms develop 'lateral ties among themselves through strategic alliances' (Etzkowitz,
2002:2).

Secondly, the influence of one helice upon another illustrates the breakdown of
previously strong boundaries between the institutional spheres to a more flexible
overlapping system. This is evident when the university becomes a firm founder;
industry becomes an educator through company universities; while the government
becomes a venture capitalist (Etzkowitz, 2002:2). Another dimension of this is where,
for example, the government enacts policy that has effects on another institutional
sphere. Etzkowitz (2002:2) illustrates this through the example of the Bayh-Dole Act
of 1980 by the federal government on industrial policy on ‘disposition of IP produced
from government-sponsored research’, which led to the spread of technology transfer
activities to a much broader range of universities’ and the ‘emergence of the academic
technology transfer profession’. Further, the interactions between individuals and
organisations from different institutional spheres can be bottom-up or top-down,
encouraged by policy measures (Etzkowitz, 2002:4). Finally, the creation of a new
overlay of trilateral networks and hybrid organisations at the interfaces from the
interaction of these helices formed for the purpose of innovation.

The net effect of these triadic interactions, communication and hybrid organisations is
the creation of an ‘innovative environment’, a ‘knowledge infrastructure’ that
facilitates the capitalisation of knowledge, right from its generation, codification and
utilisation through trilateral initiatives for knowledge-based economic development
(Etzkowitz and Leydesdorff, 2000:110). The emphasis is knowledge and technology
transfer as a function of the complex set of formal and informal linkages between the
science system, finance and commercial businesses, and the government (Harding,
2007:6). The networks of university-industry-government relations are institutional
arrangements for configuring knowledge into a hypothesized space, a theoretical
construct referred to as the knowledge-based economy. Leydesdorff (2012) argues
that events in a knowledge-based economy can be positioned in this three-
dimensional space, and can be described in terms of a three-way interaction among
the three institutional spheres. This interaction among the spheres can be depicted as
alternating between two integrative mechanisms: bilateral and multilateral co-
ordination. However, the innovation system remains in transition because each of the institutional spheres has its differentiating mission within this integrating mechanism. The complex system can operate trans-disciplinarily, and one can translate contexts of discovery and justification into contexts of application and vice versa without damaging the integrity of the underlying institutional and communicative processes. This imaginative restructuring may loosen existing boundaries at the institutional level and thus reshape the systems of innovation.

In summary, then, the Triple Helix thesis is a model of economic and social development that contextualizes innovation within collaborations across institutional divides, and recognizes that the roles of partners in such collaborations are not fixed in a knowledge-based economy. In its dynamic overlay of interactions and communication between industrial, academic and administrative discourses, new options and strategies can strengthen innovation. The results are both the development of new products in firms but also the creation of new arrangements among the institutional spheres that foster the conditions for innovation.
1.11 Conceptual Framework

The conceptual framework underlying this study was based on the Triple Helix theory as formulated by Etzkowitz and Leydesdorff (2000). The customized Triple Helix configuration presented below emphasizes the university as the driver of knowledge-based industrialization in the Kenyan context. Essentially, this framework consists of three key actors in the innovation system as independent variables: government as a source of facilitation through policy and other incentive mechanisms; the knowledge base in the form of higher education institutions (HEIs) especially the apex institution—the university; and the context of production and innovation, the manufacturing firm. The key policy frameworks and incentive mechanisms target the national development framework, industrial, STI and human resource development policies. The knowledge base is constituted by a predominantly entrepreneurial or third mission-oriented university. Finally, the manufacturing enterprise scene is constituted by a set of enterprises that are driven by the need for innovation and are increasingly technology-dependent for improved productivity and competitiveness. The resultant macro independent variable is therefore the linkages within these institutional spheres whose synchronised evolution results in the dependent variable, the knowledge-based economy.

Figure 1.2 illustrates this interaction between these players particularly through a coordinating mechanism that captures the overlay of communication from the institutional spheres, which then funnels the synergies into the creation of a knowledge-based economy in general or a certain sector of the economy—in this study, manufacturing. The model illustrates what should be happening in each institutional sphere and the need for a co-ordinated co-evolution in each sphere so as to unleash synergised forces that create the knowledge economy’s base. The overlay space helps
to resolve the tensions that arise from the dynamic forces in the integrative yet idiosyncratic processes happening within the institutional spheres. The synergy space does not imply steps that should characterise the process of creating the knowledge economy, but an illustration of what should be critical components in that process. This synergy space is constituted of Etzkowitz’s hybrid organizations that facilitate the capitalization of knowledge and technology, and its transfer to industry. They are chiefly constituted of the ILOs, the TTOs, the STPs, SEZs (clusters) and incubators. Such hybrid institutions within the context of the NIS are illustrated below:
The creation of these platforms, herein referred to as the UIGLs, and their contextualization in both industrialization policymaking and uptake by manufacturing firms, depends on the identification and resolution of the challenges that face such an undertaking. These are also captured in the conceptual framework drawn in Figure 1.2 below:

![Conceptual Framework](image)

**Figure 1.2: Conceptual Framework for University-Industry-Government linkages and relationship to a knowledge-based manufacturing sector**
1.12 Operational Definition of Terms

Commercialization: The process of developing and turning new ideas, research output, scientific discoveries and inventions into marketable or commercial products in the manufacturing sector of the economy and putting them in the market. This includes licensing patents, creating ‘spin-out’ companies, and the movement of expertise or technology from one organization to another.

Industrialization: The process by which Kenya envisions to build its capacity to process raw materials for consumption or further production, a means of achieving structural transformation of the economy.

Innovation: The implementation by a manufacturing enterprise of a new or significantly improved product(good), process, or external relations.

Intellectual Property: The legal rights which result from intellectual activity in the industrial (industrial property) and scientific fields (i.e. copyrights).

Knowledge-based Economy: The economy envisaged by Kenya Vision 2030 that is based on the production, distribution and use of knowledge and information, characterised by a greater dependence on knowledge, information and high skill levels, and the increased need for ready access to all of these by the business and public sectors. This is represented by a knowledge-based manufacturing sub-sector increasingly producing medium to high tech goods (OECD, 1996:7; OECD, 2005: 28; Powell and Snellman, 2004:201).

Knowledge-based Society: A society by Kenya Vision 2030 that puts a premium on generation, adaptation, acquisition and utilisation of knowledge and innovations to
realise and maximize benefits in social, economic and technological development (RoK, 2006:1).

**Linkages:** These are interactions among actors in the innovation system, the manufacturing firm, universities and the government, characterised by learning and the transmission of information, knowledge, technologies, practices, human and financial resources. The ultimate result is the transfer of these elements into innovations and a growth of the knowledge component in finished firm output. They include consultancy services by universities, training, research, incubators, science parks, start-up firms, among others.

**Manufacturing:** Addition of value on the basis of knowledge and technology to raw materials so as to come up with intermediate or finished products.

**National Innovation System:** A set of institutions whose interactions determine the innovative performance of firms and industry. These include the manufacturing enterprise, industrial research laboratories, universities and other research institutions, and the government. It can also be described as a set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.

**Research and Development:** Creative work undertaken on a systematic basis in order to increase the stock of knowledge and its use to devise new applications for the manufacturing sector of the economy.
Science: Generalizable and replicable knowledge of nature, usually resulting from basic science performed in universities and reproduced in refereed and published papers.

Technology: Knowledge of artefacts, such as products, processes, etc. usually resulting from applied research, development and related activities (design, testing, production engineering, quality control) and embodied in the production of the artefacts themselves for the manufacturing sector of the economy.
CHAPTER TWO  

REVIEW OF RELATED LITERATURE

2.0 Introduction

This chapter reviewed theoretical and empirical studies that investigate the fundamental relationships that underpin this study and which were operationalised in the conceptual framework. Theoretical trends in these relationships were highlighted and supporting and contradictory evidence examined and evaluated. Ultimately, conceptual, empirical and methodological gaps that this study sought to fill were identified in the summary of the chapter.

The purpose of this study was to examine the contribution of universities in Kenya to the country’s industrialisation agenda through university-industry-government linkages in the manufacturing sub-sector of the economy. The following specific objectives guided the study: to

i. Examine the extent to which the entrepreneurial concept exists in universities in Kenya with specific application in the manufacturing sector of the economy;

ii. Analyse the motivations for the creation of linkages between universities, manufacturing industry, and the government in the context of knowledge-based manufacturing;

iii. Examine the extent to which these linkages can contribute to the attainment of knowledge-based manufacturing in Kenya;

iv. Identify the challenges facing the development of these linkages;

v. Suggest interventions to be instituted to enhance the potential of the linkages to promote the development of knowledge-based manufacturing in Kenya.
These objectives are the structural basis for the themes upon which this chapter is organised.

2.1 Theoretical Literature

The central relationship explored in this research study is that between knowledge, technology, economic growth and development policy. Four theoretical strands converge to underpin the relationship in this study. *Endogenous growth theory* postulates that innovation and knowledge transfer from within the economic system are key drivers of economic growth by generating productivity growth (Harding, 2007:6). The second theoretical approach is the *new growth theory* which explains the forces which drive long-term economic growth (OECD, 1996:11). According to Powell and Snellman (2004: 207) conventional economic theory accounts for growth as a result of two factors - labour productivity growth and labour supply growth. The productivity of labour is said to depend on growth in productive inputs such as capital intensity and the quality of the labour force. The part of economic growth that is unaccounted for by increase in inputs is referred to as the Solow residual or multifactor productivity (MTP) which results from technical progress and improved efficiency. In this approach, knowledge can raise the returns on investment, which can in turn contribute to the accumulation of knowledge. It does this by stimulating more efficient methods of production as well as new and improved products and services. There is thus the possibility of sustained increases in investment which can lead to continuous rises in a country’s growth rate. Knowledge can also spill over from one firm or industry to another, with new ideas used repeatedly at little cost thus easing the constraints placed on growth by scarcity of capital.
The third strand, **Systems theory**, looks at innovation as a system, a perspective that studies the influence of external institutions on the innovative activities of firms and other actors (OECD, 2005: 32; Gault, 2010: 20-32; Lundvall, 2010: 2-17; Nelson, 1993: 3-20). It emphasizes the importance of the transfer and diffusion of ideas, skills, knowledge and information as well as other signals. Innovation is viewed as a dynamic process in which knowledge is accumulated through learning and interaction. Systems approaches shift the focus of policy to the interplay of institutions and look at interactive processes in the creation, diffusion and application of knowledge. The view of innovation as a system is a perspective that studies the influence of external institutions on the innovative activities of firms and other actors (OECD, 2005: 32). They also emphasize the importance of the conditions, regulations and policies in which markets operate and hence the role of government in monitoring and seeking to fine-tune this framework (OECD, 2005: 33).

The fourth strand is the **Triple Helix (TH) theory**, a non-linear model of innovation. This approach states that the university can play a leading role in innovation and the creation of a knowledge-based society due to its comparative advantage as a knowledge institution (Etzkowitz and Leydesdorff, 1995; Etzkowitz and Leydesdorff, 2000: 109; Etzkowitz, 2002: 2). The fundamental proposition of the theory is that innovation is the outcome of linkage networks or ‘multiple reciprocal relationships’ among universities, industries and governments. These three actors form the three spheres of the Triple Helix. There are three dimensions of the model representing interlocking dynamics: internal transformation in each of the helices; the influence of one helice upon another; and the creation of a new overlay of trilateral networks and hybrid organisations at the interfaces from the interaction of these helices formed for the purpose of innovation (Etzkowitz, 2002: 2; Etzkowitz, 2013: 8).
Internal transformation in each of the spheres can be illustrated in the university sphere, which incorporates an entrepreneurial orientation into its mission (Guerrero and Urbano, 2013: 11; Mathieu, 2013:18; Etzkowitz, 2013:21; Etzkowitz, 2004:64). Etzkowitz (2013:22-23; 2004: 70-74) traces the development of academic entrepreneurship as the university moved from being a ‘conservator of knowledge to an originator of knowledge’, from an institution for ‘conserving and transmitting knowledge’ into an institution in which ‘knowledge is also created and put into use’. This is not a linear process either expressed as ‘market pull’ or ‘technology-push’, but an interactive one in which there is a back-and-forth movement ‘starting from research to utilisation and reverse from problems in industry and society and seeking solutions in science’ (Etzkowitz, 2004:69; Etzkowitz and Leydesdorff, 2000:110). He illustrates this intentional and links-driven entrepreneurial process within the university structures of knowledge and technology transfer, starting from liaison offices, technology transfer offices, and firm formation by entrepreneurs. Thus this ‘capitalisation of knowledge’ becomes the basis for economic and social development, thus the university’s enhanced role’.

On the part of government, there is a development policy shift from an industrial economy that ‘reflects the predominant production factors of capital and unskilled labour’ to an entrepreneurial one in which ‘the dominant factor is knowledge capital as a source of competitive advantage, complemented by entrepreneurship capital representing the capacity to engage in and generate entrepreneurial activity’ (Guerrero and Urbano, 2013:11). The authors, citing Porter, et al (2012) summarise the transition as movement from a factor- to efficiency- to innovation-driven economy. Firms develop ‘lateral ties among themselves through strategic alliances’ (Etzkowitz, 2002:2).
Secondly, the influence of one helice upon another illustrates the breakdown of previously strong boundaries between the institutional spheres to a more flexible overlapping system. This is evident when the university becomes a firm founder; industry becomes an educator through company universities; while the government becomes a venture capitalist (Etzkowitz, 2002:2). Another dimension of this is where, for example, the government enacts policy that has effects on another institutional sphere. Etzkowitz (2002:2) illustrates this through the example of the Bayh-Dole Act of 1980 by the federal government on industrial policy on ‘disposition of IP produced from government-sponsored research’, which led to the spread of technology transfer activities to a much broader range of universities’ and the ‘emergence of the academic technology transfer profession’. Further, the interactions between individuals and organisations from different institutional spheres can be bottom-up or top-down, encouraged by policy measures (Etzkowitz, 2002:4). Finally, the creation of a new overlay of trilateral networks and hybrid organisations at the interfaces from the interaction of these helices formed for the purpose of innovation.

The net effect of these triadic interactions, communication and hybrid organisations is the creation of an ‘innovative environment’, a ‘knowledge infrastructure’ that facilitates the capitalisation of knowledge, right from its generation, codification and utilisation through trilateral initiatives for knowledge-based economic development (Etzkowitz and Leydesdorff, 2000:110). The emphasis is knowledge and technology transfer as a function of the complex set of formal and informal linkages between the science system, finance and commercial businesses, and the government (Harding, 2007:6). The networks of university-industry-government relations are institutional arrangements for configuring knowledge into a hypothesized space, a theoretical
construct referred to as the knowledge-based economy. Leydesdorff (2012) argues that events in a knowledge-based economy can be positioned in this three-dimensional space, and can be described in terms of a three-way interaction among the three institutional spheres. This interaction among the spheres can be depicted as alternating between two integrative mechanisms: bilateral and multilateral coordination. However, the innovation system remains in transition because each of the institutional spheres has its differentiating mission within this integrating mechanism. The complex system can operate trans-disciplinarily, and one can translate contexts of discovery and justification into contexts of application and vice versa without damaging the integrity of the underlying institutional and communicative processes. This imaginative restructuring may loosen existing boundaries at the institutional level and thus reshape the systems of innovation.

Thus, the Triple Helix thesis is a model of economic and social development that contextualizes innovation within collaborations across institutional divides, and recognizes that the roles of partners in such collaborations are not fixed in a knowledge-based economy. In its dynamic overlay of interactions and communication between industrial, academic and administrative discourses, new options and strategies can strengthen innovation. The results are both the development of new products in firms but also the creation of new arrangements among the institutional spheres that foster the conditions for innovation.

2.2 Innovation and Economic Development

It is now widely acknowledged in academic and policy circles that more than ever before, the generation, exploitation and diffusion of knowledge and technology through innovation are fundamental to economic growth and development and to the
creation of the knowledge-based economy. Although the conceptual links between innovation and knowledge-based economic growth in particular and between innovation and development in general are clear, the empirical evidence is not so linear. It is easy to argue that universities and the science system generate new knowledge and technological inventions. It is also easy to argue that innovation leads to the introduction of new products and processes in the market, thereby leading to the growth of output and its diversification, and that it leads to efficiency in processes thereby increasing total factor productivity (TFP). However, the understanding of how innovation itself occurs, the relevant indicators of innovation, its ecosystem, and its economic impact in various country and development contexts are aspects that are only beginning to grow (OECD, 2005:10; Barry and Sawyerr, 2008:2-3; Gault, 2010:134).

Gault (2010) in a classic handbook sets the stage for a discussion of the subject by looking at what innovation is, how it is measured and how policies are developed and implemented to support it in the context of unique cultures, history and government policy frameworks. He begins by looking at the global context for innovation and notes that global challenges are usually the principal motivators of the innovation that leads to sustainable productivity growth and human development. Citing the example of OECD countries, he notes that there has been economic growth though with some slow-downs, a spreading of ICTs, change in dietary habits, the emergence the ageing population phenomenon, fluctuations in the price of oil and introduction of biofuels with concerns of climate change growing and resulting debate on food policies, natural disasters, and security. These issues can be extended to the developing world such as Africa where issues of global warming, civil unrest, fragile nations, infectious
diseases, depletion of natural resources, pollution, energy costs, poverty, equity, urbanization among others are critical for the survival of the continent, a view shared by Mugabe (2009:11-12).

Gault's core argument is that innovation—which he defines as 'the creation of value from knowledge' and 'bringing products to the market'-can deliver increased and sustained productivity growth, leading to economic growth. He adds that innovation is global, systemic, complex, dynamic and non-linear. With regard to the marketization of knowledge and technology he notes that there is need for innovation policy because of the convergence of S&T policy and the political economy.

This section's discussion of innovation and how it can lead to the actualization of a knowledge-based economy is undergirded by principles adopted from Gault's schema: a systems approach; a common language for the concepts involved; innovation strategies, their components and coordination. In this section, the focus will be on the systems approach, the common language adopted through the innovation indicators system, and its co-ordination in the global scene. The next section will focus more on the critical area of innovation outcomes in the economy in the form of a knowledge-based economy.

2.2.1 National Innovation Systems

Gault (2010:21) begins by pointing out that a systems approach implies actors engaged in innovation-related activities with linkages with other actors, which result in short- and longer-term economic and social impacts. The actors are governments, businesses, private non-profit organizations, and institutions of education and research. Their activities include R&D, invention, innovation, training and
development, capital investment, and IPR protection. Linkages include any interaction among actors, such as contracts, licensing of IPRs, flows of data/information/knowledge from or to public or private sources, collaboration, and exchange of human resources. Outcomes can be any consequence of the activities and linkages, such as changes in employment, skill levels or market share as a result of innovative activity. Impacts take longer to emerge, and are diverse. They may include rapid provision of standard food products to consumers as a result of food services innovation but also the growth of obesity/Type II diabetes/heart disease from the fats and sugars in the foods. ICT innovations such as broad-band communications and portable electronics/software have propelled new industries providing web-based content to new consumers. Thus, innovations can have both positive and negative impacts (Gault, 2010: 21-22). The systems view and its use as an analytical tool has gained near-global acceptance among scholars in the area of innovation (Nelson, 1993; Lundvall, 1992, etc.) and populates STI sections in policy debates and literature.

A system of indicators has also evolved to describe innovation and innovation systems. Again Gault (2010: 36-37; 44; 135-140) comes in handy for a general picture. In the developed world, he traces the interest in innovation and innovation measurement to Schumpeter in 1934, the National Experts on Science and Technology Indicators (NESTI) resulting in the first edition of the Frascati Manual (FM) in 1963. From there he moves on to the work of the Nordic Council in the 1970s and 80s, and of the OECD Working Party of NESTI, resulting in the Oslo Manual in 1992. The work of OECD NESTI, however, has roped in other countries outside of the OECD and EU such as Israel, the Russian Federation, South Africa and other
bodies such as UNESCO, Institute of Statistics, Network on Science and Technology Indicators, and NEPAD’s Office of Science and Technology (OST).

In Latin America, the work of the Network on Science and Technology Indicators Ibero-American and Inter-American (RICYT), the Organisation of American States (OAS), and the Latin-American Science and Technology Development Programme (CYTED) led to the development of the Bogota Manual (BM) (Gault, 2010:135-137).

In Asia, the Asia-Pacific Economic Co-operation (APEC), which also has some OECD countries (Australia, Canada, Korea, Japan, New Zealand, US), the Industrial Science and Technology Working Group (ISTWG), and the Association of South East Asian Nations (ASEAN) deal with innovation and indicators (Gault, 2010: 140).

In Africa, the approach to indicator development has been led by the NEPAD and AU (Gault, 2010: 137-140). In 2003, the first NEPAD African Ministerial Council on Science and Technology (AMCOST I) in Johannesburg, South Africa resolved to develop and adopt a common set of indicators to benchmark national and regional systems of innovation and also adopted what later became the Consolidated Plan of Action (CPA) as the basis of NEPAD’s business plan on science and technology. The CPA was adopted in AMCOST II, the same forum where countries resolved to establish an intergovernmental committee and national authorities to develop, adopt and use common innovation indicators and to prepare an African Science, Technology and Innovation Indicators (ASTII) Report, now known as the African Innovation Outlook (AIO). Currently the OECD’s Frascati and Oslo Manuals are what guide NEPAD’s OST’s innovation surveys as adopted in the first meeting of the African Intergovernmental Committee on ASTII in Maputo in 2007.
What are these innovation indicators? First the Oslo Manual, which started with a focus on technological, product and process innovations in its first edition, has grown to a third edition. This edition has a focus on a broader definition of innovation beyond a technological emphasis, on a systems approach, on knowledge management activities, among other areas (Gault, 2010: 37-43). It spans 8 chapters: Objectives and Scope of the Manual; Innovation Theory and Measurement Needs; Basic Definitions; Institutional Classifications; Linkages in the Innovation Process; Measuring Innovation Activities; Objectives, Obstacles, and Outcomes of Innovation; Survey Procedures (OECD, 2005). It also contains an Appendix on Innovation Surveys in Developing Countries. The measurement of innovation using this Manual as a guideline occurs through what is referred to as the Community Innovation Survey, CIS. This survey instrument has guided measurement of innovation in most OECD countries in and outside of the European Union, in China, Russian Federation, Africa, Latin America and most recently in the United States. The CIS, a firm-level, cross-sectional survey tool, consists of 11 parts: General Information about the enterprise, business, company or firm; Product Innovation; Process Innovation; On-going or Abandoned Innovation Activities; Most Important and Performed Innovation Activities and Expenditures; Sources of Information and Co-operation for Innovative Activities; Effects/Objectives of Innovation; Factors Hampering Innovative Activities; IPRs; Organisational and Marketing Innovations; Specific Innovations by Enterprise (See Appendix for a copy of the CIS instrument). Figure 2.1 summarizes the OM’s innovation measurement framework.
The USA uses the US Business R&D and Innovation Survey (BRDIS) developed by the US National Science Foundation (NSF) in collaboration with the Economic Directorate of the Bureau of the Census (Gault, 2010:57-59). There are also technology surveys such as the Statistics Canada Advanced Technology Survey 2007.

Finally, at a macro level, the measurement of economic impact relies on whatever organ that collects economic data. The System of National Accounts (SNA) collates data from all parts of the economy and calculates the Multi-Factor Productivity (MFP), an residue that measure that portion of labour productivity growth that cannot be accounted for by measuring the growth of capital intensity and the quality of the workforce (Gault, 2010: 66-67). The measurement of economic impact has received
very little focus, yet this is where the contribution of innovation to economic growth and development can be most evident. Thus, this implies that empirical studies to measure such impact have not received attention in the absence of a measurement framework. This constitutes the first gap in the literature.

In order to capture how countries compare with regard to their national innovation systems, there have emerged regional and global innovation indexes. These use common indicators of innovation to rank the participating countries and have become sources of information for scholars interested in innovation as well as policymakers who would like to use the data to inform policy processes. Two are mentioned here: the African Innovation Outlook (AIO) and the Global Innovation Index (GII).

The AIO, as noted earlier, is an outcome of the ASTII, and publishes the innovation capacity and performance of participating countries. Its first edition covering innovation in 19 countries was released in 2010, the second ought to have been published in April 2012 with an additional 9 countries, and the most recent with an additional 7 countries - bringing a total of 35 - was released in April 2014 (NEPAD, 2014:3). The indicators reported on are drawn from R&D surveys based on the Frascati Manual, from Innovation surveys drawn from the Oslo Manual, and from bibliometric indicators.

R&D surveys focus on the Gross Domestic Expenditure on R&D (GERD) by source and sector of performance; R&D personnel by level of formal qualification, occupation, gender, headcount (HC), and full-time equivalent (FTE); and researchers by field of science. The details of the innovation survey through the CIS were outlined earlier. Finally, bibliometric indicators include: number of scientific
publications/scientific output; number of citations per capita; growth, impact factor, specialization and citations; scientific output by domain, field and sub-field of science; collaboration; and characteristics of the most active scientists (NEPAD, 2014).

Although it is a rich source of information on innovation, the AIO is significantly weakened by the fact that the results of these surveys are not comparable due to different reference periods, different coverage of sectors, and different sampling methods, among others (NEPAD, 2014, XXXII). In the 2014 AIO, the key findings were that innovation is pervasive across the subtypes; not all innovation activities were successful; innovation originated within countries; acquisition of machinery and intramural R&D formed the largest share of innovation expenditure; innovation is a connected activity; innovations had an impact; lack of funds within the enterprise was the most predominant barrier; some firms acquired IPRs in innovations; and more firms innovated than did R&D (NEPAD, 2014: XXXI-XXXII).

The GII relies on two sub-indices: the Innovation Input Sub-Index and the Innovation Output Sub-Index (Cornell University, INSEAD, & WIPO, 2013: 6-7). The Innovation Input Sub-Index is built around 5 pillars: Institutions (political environment, regulatory environment, business environment), Human Capital and Research (education, tertiary education, R&D), Infrastructure (ICT, general infrastructure, ecological sustainability), Market Sophistication (credit, investment, trade and competition), and Business Sophistication (knowledge workers, innovation linkages, knowledge absorption). These pillars capture elements of the national economy that enable innovative activities. The Innovation Output Sub-Index has 2 output pillars: Knowledge and Technology Outputs (knowledge creation, knowledge
impact, knowledge diffusion) and Creative Outputs (intangible assets, creative goods and services, online creativity). These are the results of innovative activities within the economy. The overall GII score is the simple average of the Input and Output Sub-Indices, 84 indicators in total. The Innovation Efficiency Ratio is the ratio of the Output Sub-Index over the Input Sub-Index, and shows how much innovation output a given country is getting for its inputs.

These indices are used for comparative purposes. An example of such comparative analyses is presented through tables 1.1, 1.2 and 1.3, showing critical aspects of innovation systems in three types of country groupings: large and small high income countries and low income countries. Also included are measures of the economic performance of the three types of country groupings.

The large income countries are populous and affluent but differed in when they began their strong economic development. The UK was the pioneer in the first industrial revolution and the USA followed in the mid-nineteenth century. Germany comes on board later in the nineteenth century followed by France and Italy. Japan had hardly begun her modernization at the turn of the century. However, Japan had the fastest growth of GDP per capita among the six countries, while the UK and USA have the slowest. Due to its big internal market Japan has the lowest ratio of exports to GDP. In all these countries, manufacturing exports accounted for the majority of total exports. The literacy rate and secondary level enrolment ratios in all of these countries were very high. The US had a significantly larger fraction of third-level enrolments, though it had a smaller fraction of university students taking science and engineering. The US, Japan, and Germany led in R&D as a fraction of GDP, but in all of these countries majority of R&D was undertaken in business enterprises. A significant part
of that R&D was financed by government in the US, UK and France as contrasted with Japan and Germany.

Table 2.1: Comparison of national innovation system indicators for six large high-income countries

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>Japan</th>
<th>German</th>
<th>France</th>
<th>U.K</th>
<th>Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP/capita,1989 (official)</td>
<td>19,840</td>
<td>21,020</td>
<td>18,480</td>
<td>16,090</td>
<td>12,810</td>
<td>13,330</td>
</tr>
<tr>
<td>GDP/capita,1988</td>
<td>19,558</td>
<td>14,228</td>
<td>14,161</td>
<td>13,603</td>
<td>13,428</td>
<td>12,985</td>
</tr>
<tr>
<td>Purchasing power parity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population, 1988</td>
<td>246,329</td>
<td>122,613</td>
<td>61,451</td>
<td>55,873</td>
<td>57,065</td>
<td>57,441</td>
</tr>
<tr>
<td>Average growth rate</td>
<td>1.6</td>
<td>4.3</td>
<td>2.5</td>
<td>2.5</td>
<td>1.8</td>
<td>3.0</td>
</tr>
<tr>
<td>GDP/hour average 1965-1988</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross domestic invest/GDP</td>
<td>16</td>
<td>29</td>
<td>19.5</td>
<td>23.5</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>average 1965-1988</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing output/GDP</td>
<td>22</td>
<td>29</td>
<td>44</td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Manufacturing exports/GDP</td>
<td>5</td>
<td>9</td>
<td>24</td>
<td>13</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>Total exports/GDP</td>
<td>7.4</td>
<td>16.5</td>
<td>32.4</td>
<td>17</td>
<td>20.7</td>
<td>15.5</td>
</tr>
<tr>
<td>Literacy rate</td>
<td>&gt; 95</td>
<td>&gt; 95</td>
<td>&gt; 95</td>
<td>&gt; 95</td>
<td>&gt; 95</td>
<td>&gt; 95</td>
</tr>
<tr>
<td>Secondary level enrolment</td>
<td>98</td>
<td>96</td>
<td>94</td>
<td>92</td>
<td>83</td>
<td>75</td>
</tr>
<tr>
<td>Third-level enrolment rate</td>
<td>60</td>
<td>28</td>
<td>30</td>
<td>31</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>Scientists and engineers/</td>
<td>0.33</td>
<td>0.48</td>
<td>0.25</td>
<td>0.19</td>
<td>0.17</td>
<td>0.12</td>
</tr>
<tr>
<td>population</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;D/GNP</td>
<td>2.9</td>
<td>2.9</td>
<td>2.9</td>
<td>2.3</td>
<td>2.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Private R&amp;D/Total R&amp;D</td>
<td>48</td>
<td>78</td>
<td>64</td>
<td>42</td>
<td>49</td>
<td>42</td>
</tr>
<tr>
<td>BERD/Total R&amp;D</td>
<td>72.5</td>
<td>66</td>
<td>72.2</td>
<td>58.9</td>
<td>67</td>
<td>57.2</td>
</tr>
<tr>
<td>Private business R&amp;D/Total</td>
<td>66.4</td>
<td>98</td>
<td>86.5</td>
<td>69</td>
<td>68.2</td>
<td>71.7</td>
</tr>
</tbody>
</table>

The next set of countries has smaller populations and is also affluent on the basis of GDP per capita. They had small internal markets and have high literacy rates and enrolments in secondary and third level education. Sweden resembled the category of nations above with regard to the share of manufacturing in GDP, the share of manufacturing exports in total exports, and the ratio of R&D in GDP. In Australia, Canada and Denmark, agriculture and resource exploitation accounted for a larger share of economic activity and of their exports. Except Sweden, BERD accounted for a smaller fraction of total R&D, with a larger share going on in universities and government laboratories.

Table 2.2: Comparison of national innovation systems indicators for four “small” high-income countries

<table>
<thead>
<tr>
<th></th>
<th>Sweden</th>
<th>Denmark</th>
<th>Canada</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP/capita, 1989 official exchange rates</td>
<td>19,300</td>
<td>18,450</td>
<td>16,960</td>
<td>12,340</td>
</tr>
<tr>
<td>GDP/capita, 1988 purchasing power parity</td>
<td>14,772</td>
<td>13,555</td>
<td>18,446</td>
<td>13,6413</td>
</tr>
<tr>
<td>Population, 1988</td>
<td>8,438</td>
<td>5,130</td>
<td>25,950</td>
<td>16,538</td>
</tr>
<tr>
<td>Average growth rate GDP/hour average 1965-1988</td>
<td>1.8</td>
<td>1.8</td>
<td>2.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Gross domestic invest/GDP average 1965-1988</td>
<td>15</td>
<td>15.5</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>Manufacturing output/GDP</td>
<td>30</td>
<td>25</td>
<td>23</td>
<td>18</td>
</tr>
<tr>
<td>Manufacturing exports/GDP</td>
<td>26</td>
<td>19</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Total exports/GDP</td>
<td>31</td>
<td>31</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Literacy rate</td>
<td>&gt; 95</td>
<td>&gt; 95</td>
<td>&gt; 95</td>
<td>&gt; 95</td>
</tr>
<tr>
<td>Secondary level enrolment rate</td>
<td>91</td>
<td>107</td>
<td>104</td>
<td>98</td>
</tr>
<tr>
<td>Third-level enrolment rate</td>
<td>31</td>
<td>30</td>
<td>58</td>
<td>29</td>
</tr>
<tr>
<td>Scientists and engineers/ population</td>
<td>0.25</td>
<td>0.17</td>
<td>0.22</td>
<td>0.21</td>
</tr>
<tr>
<td>R&amp;D/GNP</td>
<td>3.0</td>
<td>1.3</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Private R&amp;D/Total R&amp;D</td>
<td>61</td>
<td>47</td>
<td>42</td>
<td>61</td>
</tr>
<tr>
<td>BERD/Total R&amp;D</td>
<td>66.8</td>
<td>55.6</td>
<td>55</td>
<td>37.4</td>
</tr>
<tr>
<td>Private business R&amp;D/Total business R&amp;D</td>
<td>87</td>
<td>85.9</td>
<td>71.8</td>
<td>93.3</td>
</tr>
</tbody>
</table>

With the exception of Israel, the countries in the lower income category are populous but had relatively small internal markets for manufactured goods due to their low levels of income. These countries had had varying fortunes in economic growth. Prior to the Second World War, Argentina’s per capita income levels were comparable to those in Continental Europe. However, it has been marked with stagnation. Korea and Taiwan have experienced rapid and sustained growth, while Brazil and Israel have grown slowly in recent years. These countries stood close to each other in terms of manufacturing output as a ratio of GDP, though they differed in ownership of manufacturing with more Foreign Direct Investment (FDI) in Brazil and Argentina and little of it in Korea and Taiwan. Korea and Taiwan had a very large share of manufacturing exports in total exports closely followed by Israel. Argentina and Israel fared well in literacy rates, but Korea and Taiwan have been catching up rapidly. These countries were also making progress in secondary and third level enrolments. The ratio of R&D/ GNP followed the pattern of the figures for the stock of scientists and engineers as a fraction of the population. In Argentina, Brazil and Israel the majority of R&D was publicly funded with most happening in universities and government laboratories in the first two and the other taking place in the military in Israel.
Table 2.3: Comparison of national innovation system indicators in five lower income countries

<table>
<thead>
<tr>
<th></th>
<th>Korea</th>
<th>Taiwan</th>
<th>Brazil</th>
<th>Argentina</th>
<th>Israel</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP/capita,1989 official exchange rates</td>
<td>3600</td>
<td>8000</td>
<td>2160</td>
<td>2520</td>
<td>8650</td>
</tr>
<tr>
<td>Population (World Development report, Except Taiwan)</td>
<td>42.5</td>
<td>16.2</td>
<td>147.3</td>
<td>31.9</td>
<td>4.5</td>
</tr>
<tr>
<td>Average growth rate GDP/hour average 1965-1988</td>
<td>6.8</td>
<td>6.5</td>
<td>3.6</td>
<td>0</td>
<td>2.7</td>
</tr>
<tr>
<td>Gross domestic invest/GDP average 1965 - 1988</td>
<td>22.5</td>
<td>32</td>
<td>21.5</td>
<td>16.5</td>
<td>23</td>
</tr>
<tr>
<td>Manufacturing output/GDP</td>
<td>32</td>
<td>-</td>
<td>29</td>
<td>31</td>
<td>-</td>
</tr>
<tr>
<td>Manufacturing exports/GDP</td>
<td>33</td>
<td>-</td>
<td>5</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Total exports /GDP</td>
<td>42</td>
<td>55.7</td>
<td>10</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>Literacy rate</td>
<td>88</td>
<td>92</td>
<td>78</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Secondary level enrolment ratio</td>
<td>88</td>
<td>-</td>
<td>39</td>
<td>74</td>
<td>83</td>
</tr>
<tr>
<td>Third-level enrolment ratio</td>
<td>36</td>
<td>-</td>
<td>11</td>
<td>39</td>
<td>34</td>
</tr>
<tr>
<td>Engineers as a percent of population</td>
<td>0.11</td>
<td>-</td>
<td>0.04</td>
<td>0.06</td>
<td>0.47</td>
</tr>
<tr>
<td>R&amp;D/GNP</td>
<td>1.0</td>
<td>1.16</td>
<td>0.4</td>
<td>0.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Private R&amp;D/Total R&amp;D</td>
<td>81/29</td>
<td>40/60</td>
<td>20/80</td>
<td>8/92</td>
<td>22/78</td>
</tr>
<tr>
<td>Direct Foreign investment/GDP</td>
<td>1.9</td>
<td>2.0</td>
<td>11.1</td>
<td>23.9</td>
<td>-</td>
</tr>
</tbody>
</table>


How about African countries? In one of the most comprehensive studies of innovation in Africa, Mugabe (2009:29-36) describes the innovation scene in Africa and then generates STI profiles for 18 countries in the continent. The STI profile is based on indicators of innovation; country specific strategies and policies; in-country capacity; regional and STI initiatives; and financial support for STI. The indicators include: FDI as percentage of GDP, GERD, firm-level technology absorption (the
Global Competitiveness Ratio, GCR Index), BERD, high-tech exports as a percentage of manufactured exports, percentage of imported technologies used in the domestic market, UNCTAD Technology Achievement Index (TAI), number of institutions providing technical training, number of researchers in R&D (including R&D per million population), Science and Engineering (SET) enrolment ratio as a percentage of tertiary level students, number of SET graduates per million population, scientific and technical journal articles published (including per million population), royalty and license fee payments, and patent applications granted by the USTPO per million population.

Strategies and policies focus on existence of a national ministry or department of S&T, explicit R&D policy, explicit innovation policy and strategy, and STI focus areas. In-country capacity focuses on STI agencies, networks and partnerships. These include: national science councils; research centres; public and private sector R&D institutes; university-industry collaborations; existence of courses in science policy, research management, technology transfer, entrepreneurship and management; existence of infrastructure for technology transfer and incubation; number of institutions offering metrology, standards, testing and quality assurance related services; agencies and organisations conducting research in SET; support services and training provided by technology incubators; number of technology transfer offices, both private and public; number of professional associations in SET (e.g. journal societies, research networks, expert networks); and local and international STI associations. Regional and continental STI initiatives also come in the picture, as do international ones such as international STI research partnerships and networks. Financial support for STI can take the form of availability of venture capital, agencies
for funding R&D and innovation, agencies funding co-operation and the extent of their involvement, and bilateral or multilateral funding agreements with donors.

From these indicators, Mugabe (2009:4-5) makes the following observations about the situation in Africa:

i. Many African countries are not technologically ready to seize opportunities presented by rapid scientific and technological developments and globalization owing to low innovative capacities;

ii. Current R&D investments are largely focused on short-term research projects, with a limited focus on building and or improving infrastructure. Therefore R&D institutions of most African countries are of low quality;

iii. Existing S&T policy instruments have put a lot of emphasis on measures for funding and organizing scientific research, without a commensurate coverage for the promotion of innovation, such as technology prospecting, procurement, diffusion and application. Innovation policies are implicit rather than explicit;

iv. Most countries do not have budgets for policy research and analysis, and have few well-trained persons to conduct research for policy. Further, STI policymaking is organised as an event rather than as a process and often not as part of national economic development policy processes and practices. Therefore, national capacities for STI policymaking are weak;

v. Only a few African countries have institutions dedicated to funding public R&D and promoting technological innovation. Again, only in a few countries is private sector funding of R&D significant. Few governments
have or are instituting policies and laws to encourage the private sector to fund public and innovation oriented R&D;

vi. In most countries, there is a mismatch between S&T policies on the one hand and development goals on the other. STI programmes are not well aligned with overall poverty reduction and economic aspirations, with most PRSPs of most African countries making passing reference to STI;

vii. Most African countries are facing severe shortages in science and engineering fields, and therefore the skill demands of many transnational, local private and public enterprises are not being met. (This observation is corroborated by a recent report by the IUCEA-BS, *Regional Higher Education Qualification Gaps-Situation Composite EAC Report* of January 2014 on the quality of graduates in the East African region). In addition, the science and engineering curriculum of universities and polytechnics tends to be irresponsive to industry needs;

viii. University-Industry collaborations are few and weak in most countries;

ix. Regional and international STI programmes of development agencies such as AU, NEPAD, ADB, UNESCO, the World Bank are not well co-ordinated in such ways as to add value to the building of national and regional systems of innovation; and

x. Regional S&T programmes of SADC, AU, and NEPAD are largely focused on R&D, with little emphasis on technological innovation.

In the Kenyan profile, there are numerous gaps in each of the broad themes. Under STI indicators, there are no up-to-date figures on GERD, BERD, number of researchers in R&D and also per million population, number of SET graduates per
million population, scientific and technical journal articles published (as well as per million population), imported technologies used in the domestic market, royalty and license fee payments, and patent applications granted by USTPO per million population. There is also no country data on private sector R&D institutes and neither does it have data on courses in science policy, research management, and technology transfer. It is also not possible to tell whether there are support services and training provided by technology incubators or the number of TTOs, both public and private. The number of international STI research partnerships is also unknown. There is no information on agencies funding co-operation or on bilateral or multilateral funding arrangements with donors. However, this is complemented by the 2014 edition of the AIO. Annexure 3A:33 (NEPAD, 2014:70-74) provides details on Kenya in the following areas: GERD, GERD by sector of performance, GERD by sources of funding, and GERD by type of R&D; R&D personnel. Section 4.4.4 deals with innovation (NEPAD, 2014:130-132); while the bibliometric analysis is found in comparative discussions (NEPAD, 2014: 151-163).

However, as West (2012: 1) observes, measurement of the performance of science and innovation systems needs to be connected to economic performance. It is to this aspect that the discussion now turns to.

### 2.2.2 Innovation and Economic Growth

From the national innovation system approach using the Oslo Manual, the theoretical connection to economic performance is explored at firm, industry and national economy level from the perspective of impact and outcomes of innovation (OECD, 2005: 109-112). At the firm level, innovation can lead to changes in productivity,
efficiency, sales and market share. This can be indicated, for example, by the percentage of sales derived from new or improved products. At industry and national level, important impacts are changes in international competitiveness and in total factor productivity (TFP), knowledge spill-overs from firm-level innovations, and an increase in the amount of knowledge flowing through networks. Powell and Snellman (2004:202) identify cost reduction for goods in widespread use and the development of entirely new goods and services as the benefits of innovation. Another approach by another OECD research team (http://kei.publicstatistics.net-May 2008: 7-12) identifies these benefits as outcomes in the form of economic growth and productivity, income dispersion, social cohesion, gender equality and environmental sustainability.

However, this approach assumes that an innovation system is exclusively driven by the business sector, the institutional sphere called industry, especially in the developed world. It downplays the role of R&D in innovation. In fact, Gault distinguishes the Lundvall dichotomy between DUI mode that describes the activities of firms that innovate without doing R&D and his STI mode that consists of science-based processes. It is instructive to observe that most of the firms involved in the ASTII CIS study of 2012 do not have active engagements with universities as sources of information for innovation and innovate without doing R&D (NEPAD, 2014: 147, 148). Thus, it is necessary to account for the development of a knowledge-based economy as an economic impact of innovation in contexts in which such an economy or at least key sectors are or need to be driven by R&D and its commercialization, and by knowledge/research institutions as is the case in the developing countries where an innovation system is only beginning to emerge (Goransson and Brundenius, 2011:3).
Thus it is to the knowledge-based economy that this review now turns to in the next section.

2.3 Innovation and the Knowledge-based Economy

The knowledge-based economy (KBE) can be viewed as one of the outcomes and impacts of an innovation system and in this case, a national innovation system whose configuration emphasizes the role of knowledge and the science system. OECD (1996:7) defines a KBE as an economy that is directly based on the production, distribution and use of knowledge and information. OECD (2005:28) describes it as an attribute of ‘advanced economies’ in which there is a trend towards ‘greater dependence on knowledge, information and high skill levels’ and towards ‘the increasing need for ready access to all of these by the business and public sectors’. Powell and Snellman (2004: 201) define it as

‘...the production of goods and services based on knowledge-intensive activities that contribute to an accelerated pace of technological and scientific advance as well as equally rapid obsolescence’.

They observe three lines of research in this area. The oldest, dating back to the 1960s, focuses on the rise of science-based industries and their role in social and economic change. The centrality of theoretical knowledge as a source of innovation now includes the new growth theory which stresses the importance of knowledge in economic growth. The second strand examines how much particular industries that are viewed as knowledge-intensive contribute to growth in productivity. The final strand is organization-oriented and focuses on the role of learning and continuous innovation inside firms. Citing the example of OECD countries, some of the indicators of such an economy are growth in high-technology investments, high-
technology industries, output and employment in such industries, levels of highly-skilled labour and associated productivity gains (OECD, 1996:36). This has underscored the importance of investments in R&D, education and training, and new managerial work structures. There is also emphasis on the importance of knowledge distribution through formal and informal networks through its codification and transmission through ICT networks, and on tacit knowledge which entails the skills to use and adapt codified knowledge in and by organizations. The latter emphasis is based on the observation that in a KBE, innovation is driven by an interactive model, the interaction of producers and users in the exchange of both codified and tacit knowledge. Thus, the configuration of the NIS consisting of the flows and relationships among industry, government and academia in the development of S&T, is an important economic determinant. However, an understanding of whether such an economy is in place and patterns in its evolution depends on the extent and quality of knowledge-based indicators (KBIs).

An OECD report outlines domains in the measurement of a knowledge-based economy and maps out indicators in 5 areas. The indicators of knowledge inputs are expenditures on R&D, employment of engineers and technical personnel, patents, and international balance of payments for technology. Knowledge stocks can be estimated from rates of return to R&D investment, annual increases in researchers in particular fields depreciated by data on personnel movements and occupational mobility, use and expiration of periods of exclusive rights.

**Flows** of knowledge, the proportion of knowledge stock that enters into the economy during some time period is measured by embodied diffusion through the introduction
into production of processes of machinery, equipment and components that incorporate new technology and disembodied diffusion through the transmission of knowledge, technical expertise or technology in the form of patents, licenses or know-how (citation analysis, patent citations). Knowledge outputs are variously measured through categorisation of industrial sectors especially manufacturing or parts of the workforce (employment) as more or less intensive in R&D (ratio of R&D expenditures to gross output), knowledge (e.g. high, medium, low-knowledge sectors) or information, and through the social and private rates of return to innovation on the economy and employment.

Measuring knowledge networks involves mapping innovation systems and the knowledge distribution power of economies through the distribution of knowledge among universities, public research institutions and industry and through the distribution of knowledge within a market between suppliers and users. Finally, the measurement of knowledge and learning, focusing on the efficiency and equity of education and training, entails the calculation of the private and social rates of return to investments in human capital both by firms and by society.

Another schema by an EU-funded project on KBIs (EU, 2008:3-12) develops and provides a critique of characteristics or drivers and performance indicators of a KBE. The main characteristics or drivers are ICT investment and use, human resources, knowledge production, entrepreneurship, and structural and organisational change. The influence of ICT investment and use lie in the opening up new areas of investment and increasing productivity growth. Human resources, particularly the highly skilled, are essential for the success of a KBE. Knowledge production and its
effective use are pre-requisites to all types of innovation. Four types of knowledge based on the work of Lundvall and Johnson are distinguished: **know-what** (knowledge about facts), **know-why** (knowledge about principles and laws), **know-how** (the ability to do something) and **know-who** (knowledge about who knows what). Entrepreneurship and creative destruction deal with attitude towards risk and firm ownership, the cost of firm creation, and the supply of venture capital and similar risk-taking investment. Organisational change relates to workplace organisation, business practices, and external relations. Performance outcomes are economic, social and environmental. The KBE has been associated with expected beneficial effects on economic growth and productivity, social cohesion and gender equality, and environmental sustainability.

Once more, based on such indicators, there have been attempts by countries and regional blocks, specifically the OECD and EU, to develop policy mechanisms to institutionalize the KBE, to measure the implementation and impact of these policies, and to benchmark these efforts with others countries. For example, VINNOVA, the Swedish Agency for Innovation System, based on the European Innovation Scoreboard (EIS) claimed that Sweden was the then most knowledge-based economy in the world. These claims were based on overall R&D intensity, HERD per capita, BERD as a percent of GDP, ICT expenditure per GDP, high-tech patents per capita, employment in high-tech services, and concentration of many large known knowledge-intensive companies such as Ericsson, Volvo, among others (Nordfors, Sandred and Wessner, 2003: 11,39). The authors, however, note that statistics related to economic growth, such as per capita income and core GNP ranking have not moved correspondingly.
In spite of the development of these indicators for the knowledge-based economy, various challenges are noteworthy (OECD, 1996:29-31; Powell and Snellman, 2003:202). The measurement of knowledge is fraught with challenges related to its quantification and pricing. The usual United Nations System of National Accounts (SNA) for measuring economic activity using input-output tables that map inter-sectoral transactions is problematic for knowledge since it is designed for traditional economic outputs. There are no stable formulae for translating inputs into knowledge creation into outputs of knowledge. Inputs into knowledge creation are hard to map. Knowledge lacks a systematic price system to serve as a basis for aggregating pieces of knowledge that are unique. Moreover, new knowledge creation is not necessarily a net addition to the stock of knowledge. Finally, obsolescence of units of knowledge stock is not documented.

More challenges arise in the measurement of the relationship between KBE statistics and economic performance statistics (OECD, 1996: 26-27). Most scientific knowledge is freely disclosed and so it is hard to trace its use and benefits when especially employed within private economic activities. Further, the results of research are often more enabling than directly applicable to technological innovation, thus obscuring any perceptible trace of its benefits. Third, new scientific knowledge may save resources that would otherwise have been expended on unfruitful scientific or technological efforts. These resource savings are not observed. In the context of financial stringency such as has been ongoing in EU and USA, ongoing debates on the nature of scientific knowledge and the role of government, the role of science and innovation in the economy has received new attention.
The closest a study has come to linking innovation policy and economic performance is Jasinski (2004: 46-63). Using Principal Component Analysis (PCA), he analyses the relationship between macro-economic performance and innovation performance as measured by innovation intensity, share of new and modernized products in aggregate industrial output, the share of technologically advanced products in aggregate industrial output and share of high-tech products in total exports. He observed that innovation performance reacted in the same direction but with a one-year delay to macro-economic changes and a two-year delay at the end of the 1990 decade. This is some proof that innovative activity followed the cyclical development of the national economy, pulled by the demand resulting from the economy’s recovery and high growth. However, innovation activities of firms were not affected by S&T policy, which was often delayed.

Whereas the evolution of the KBE is a bit easy to monitor in OECD countries on the basis of the presence of such indicators, however problematic their precision, and of considerable investments over time to improve the innovative capacity of member countries, the same cannot be easily said for developing countries. For one, statistics on the ingredients of economic sector performance disaggregated by investments in technology as well as on TFP on the one hand and investments in key indicators of innovation are generally unavailable. The European Commission (2008:13) notes:

One of the main issues for comparing KBE performance across countries is the effect of national institutional factors, including different national systems of innovation, versus differences that are due to national industrial distributions. For example, a country with many firms active in pharmaceuticals and other high-technology sectors will perform better on many science, technology and innovation indicators than a country that is highly competitive in food, textiles, and forestry...Research indicates that sector differences account for a large percentage of national variations in business R&D investments and in innovation outcomes, as would be expected.
Further, the development of NIS' in various countries depends on the country's level of development, its culture and history. Gault (2010:133-5) makes a few observations about innovation and consequently about the KBE in developing countries. The informal sector is a key economy actor. The formal business sector is not strong with very little demand for technology due to substitutability with cheaper labour as well as being in low value-addition activities, and those firms in business may focus more on innovation for survival than on formal R&D activities. They may also have a low capacity to absorb knowledge needed to create value and put new products in the market from outside the firm. The agricultural sector can be quite large, making it a fertile ground for innovation, while growing urbanization can spur innovation in the manufacturing and service sectors. Support for innovation is problematic due to insufficiently established infrastructure—broadband internet access, water, reliable energy, transport— to facilitate business. Framework conditions—courts, the education system, stable governance, health services, security, tax systems—may not be aligned to support innovation in the private sector. The innovation system may not be properly aligned and could suffer failure. These views are also shared by Goransson and Brundenius (2011: 4).

In light of the observations above, the link between innovation and economic growth is less evident in developing countries. This can be seen in comparative statistics in such platforms as the GII. The first 30 countries are in the high-income category and most are from the OECD block and from the NIC block. The first country from Africa, Uganda, lies in position 89 out of 142 countries. However, many countries in the developing world have not been left behind and have instituted mechanisms for the creation of a KBE. For example South Africa has a ten-year plan through the
Department of Science and Technology to drive the country’s transformation towards a KBE (Mugabe, 2009:14).

OECD (1996:21-27) emphasizes an important agent and an important process in the institutionalization of a KBE. This is the agency of the science system involved in the generation of knowledge and technology. The science system, consisting of universities and government laboratories, contributes to the key functions of knowledge production (developing and providing new knowledge), transmission (educating and developing new knowledge) and transfer (disseminating knowledge and providing inputs to problem solving)(OECD, 1996:21). The important process in innovation is the ability to develop an optimal configuration of the innovation system so as to obtain a productive interaction between the players needed for transforming ideas into successful products on to the market. The old chicken-egg debate as to what takes precedence between basic or applied science (from where technology emerges) has been resolved by the blurring of the earlier distinction in contemporary patterns innovation (Nelson, 1993:5-9, Mwamadzingo, 1996:14-17; OECD, 2000:4-5; Rai and Eisenberg, 2003:289).

It is the third function of transferring knowledge to economic and social actors as part of knowledge distribution networks or NIS’ that is of interest to this study, particularly through investing in skills for finding and adapting knowledge and technology for use and for developing bridging units/centres for its commercialization (OECD, 1996: 24-25). This transfer and utilization is facilitated, as earlier noted, through linkages between the various agents in a knowledge system of knowledge distribution networks. These networks are crucial to the capacity of a country to
diffuse innovations and to absorb and maximize the contribution of technology to product processes and product development.

The role of universities as part of the science system in innovation and as part of the wider national innovation system in particular has especially received a lot of attention in scholarly and policy debates within governments, regional blocs such as the OECD, and development agencies such as the World Bank, UNESCO, IIEP, IDRC, ECA, among others. For example, the World Bank has reflected the university subsector’s importance especially in the developing world in four Reports (World Bank 1994, 2000, 2002, 2009). Goransson and Brundenius (2011:3) observe that globalization, the information age, the demise of the linear model of innovation and the rise of the knowledge-based economy have resulted in knowledge production becoming closely and directly linked to economic competitiveness, economic growth and welfare creation and in the making the role of the university more prominent than before.

Goransson and Brundenius (2011) in an IDRC-UniDev project examine the changing role of academic institutions within the contexts of innovation and economic growth and development. The project worked in 12 countries: Brazil, Cuba, Uruguay, Denmark, Germany, Sweden, South Africa, Tanzania, Russian Federation, Latvia, Vietnam, and China. The authors observe that in spite of the different economic systems (liberal market economies, socialist economies), different levels of development (high-, medium, low income; industrialized, newly industrialized, industrializing), and the different roles of universities in innovation systems, the role of higher education and especially universities has proven to be a hot topic. It is
useful to look briefly at the key missions of the university and the measurement of their development for the countries that were part of the study.

The aspects of teaching mission of the university include: GER at the tertiary level, expenditure on higher education (unit costs, PPP on higher education, percentage of GDP devoted to higher education, public and private financing), and the orientation of higher education (programmes and fields of study as a percentage of total enrolments). Enrolments are growing in all countries in the study. As expected, the richest countries spend more on higher education, especially public expenditure. The role of private financing of higher education is prominent in Brazil and Latvia. Humanities are a strong discipline in Denmark, Sweden, Germany and China. Enrolments in social sciences are prominent in all study countries. In all the countries, though, there is a growing concern about lack of student interest in natural and engineering sciences to some extent. A surprising observation is the small number of students with an interest in agricultural sciences in the developing countries- Brazil, Cuba, Uruguay, South Africa, and Vietnam.

With regard to research, the authors address the subject by looking at the following aspects: where is R&D performed (public sector, business), and how many researchers there are in general and where are they concentrated. They provide statistics on GERD as percentage of GDP, GERD per capita (PPP), GERD per capita by sector (business, government, HEI), BERD, and HERD. They note that in previously highly centrally planned systems, most research was carried out in specialized government research institutions hence weak BERD and HERD. In many developed countries, it is the business sector that accounts for most performed research and who
also finance most research, hence high BERD. In many of the study’s developing
countries, many governments give high priority to university research, hence high
levels of HERD since many are publicly funded. Thus they also have a weak BERD.
In all the study’s countries, HEIs play a minor role in financing research.

With regard to researchers, the authors note the complexity in measurement since
many researchers are not necessarily doing research fulltime, thus the need to draw a
distinction between HCs and researcher density (FTEs). Sweden and Denmark have
the highest FTE (5,000/million), followed by Germany and Russia (3,000/million),
then Latvia/China/Brazil with 1,000-2,000/million, and the others such as Cuba/South
Africa/Uruguay come last with an FTE of below 400. With regard to the sector of
employment, more researchers work in the business sector than in the university in
China, Denmark, Germany, Russia, and Sweden. Thus, although university research
plays an important role in innovation systems in all the study countries, it is in the
developing countries where the business sector is weak that the role of university-
driven research in innovation is especially crucial (Brundenius and Goransson,
2011:343).

The authors also note a recurrent interest in the social relevance of universities with
regard to teaching, research and economic development (Brundenius and Goransson,
2011:348). The first two have long been instrumental in providing society with certain
skills, new knowledge and ideas. This aspect has taken on significance with what the
authors term ‘the advent of the comprehensive mass education facilities of the late
twentieth century’ when ‘the more precise tasks and obligations of the university have
become a concern for broader segments of society’. The common rationale is to
encourage universities to take on ‘a more visible role in stimulating and guiding the utilization of knowledge for social, cultural and economic development’. Thus universities face a multitude of new demands from all manner of stakeholders. Governments ask them to provide education for growing shares of age cohorts, and to develop and transfer technology to industry. Industry require them to teach relevant skills and to conduct research to support their particular needs. Civil society looks to them to address all sorts of ills plaguing society. Student bodies demand job relevant education. In study countries, universities have responded to this third mission differently. Some have interpreted that broadly while some have a narrower focus. The authors compare two categories of universities in the study’s countries on the basis of their interpretation of the third mission on the one hand and their level of GERD. Table 2.4 presents the findings:

Table 2.4: Scope of university third mission and GERD intensity

<table>
<thead>
<tr>
<th>Broad Scope: Society at Large</th>
<th>Narrow Scope: Transfer of technology to industry</th>
</tr>
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<tbody>
<tr>
<td><strong>High level of R&amp;D</strong> (above 1 % of GDP)</td>
<td>Sweden (3.63 %)</td>
</tr>
<tr>
<td></td>
<td>Denmark (2.54%)</td>
</tr>
<tr>
<td></td>
<td>Germany (2.53%)</td>
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<tr>
<td></td>
<td>China (1.49%)</td>
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<tr>
<td></td>
<td>Russia (1.12%)</td>
</tr>
<tr>
<td></td>
<td>Brazil (1.11%)</td>
</tr>
<tr>
<td><strong>Low level of R&amp;D</strong> (below 1 % of GDP)</td>
<td>Uruguay (0.44%)</td>
</tr>
<tr>
<td></td>
<td>South Africa (0.95%)</td>
</tr>
<tr>
<td></td>
<td>Cuba (0.41%)</td>
</tr>
<tr>
<td></td>
<td>Latvia (0.59%)</td>
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<tr>
<td></td>
<td>Vietnam (0.41%)</td>
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<tr>
<td></td>
<td>Tanzania (0.48%)</td>
</tr>
</tbody>
</table>

In the African context, the capacity of the university to provide such leadership in its current state is especially a concern (Barry and Sawyerr, 2008; World Bank, 2009). Bloom, Canning and Chan (2005:6) observe the relative neglect of the university sub-sector in World Bank funding of education. They note that between 1985 and 1989, 17 percent of the Bank’s worldwide education sector spending was on higher education, but declined to 7 percent between 1995 and 1999 especially after the Jomtien World Conference on Education in 1990. This was on the back of rate of returns studies that found that the social rates of return to primary and secondary education were higher. This has led to declining enrolments and the lowest academic research output in the world with just 5,839 published academic papers annually compared to over 20,000 in South Asia and over 15,000 in Latin America and the Caribbean. Yet this comes at a time when knowledge and technology are viewed as key drivers of economic transformation, poverty reduction and development of knowledge-based economies and societies. The authors used the Cobb-Douglas production function to investigate the effects of tertiary education stocks on TFP and aggregate output. They concluded that expanding tertiary education in Africa may promote faster technological catch-up, and improve the continent’s ability to maximize its economic output. From the continent’s production level at about 23 percent below its production-possibility frontier, increasing the stock of tertiary education stock by one year could maximize the rate of technological catch-up at a rate of 0.63 percentage points a year. This observation is also shared by a World Bank report on the role of universities in accelerating technological catch-up in SSA (World Bank, 2009).
As observed earlier, the role of universities in the transfer and dissemination of knowledge in Africa is especially crucial in the context of innovation and KBE. The World Bank has developed the 10 points Knowledge Economy Index (KEI) to benchmark countries on 4 aspects of the knowledge economy: the favourability for knowledge development within the economic and institutional regime; education; innovation; and ICT (Bloom, Canning and Chan, 2005:12; Lall and Kraemer-Mbula 2005:60). Most African countries are near the bottom of the KEI. South Africa, Botswana and Mauritius have score around the middle but the rest of Africa scores less than 2 points on average. Lall and Kraemer-Mbula (2005:60) make similar findings in the continent’s performance in the Technology Effort Index (TEI) that ranks countries according to a combination of enterprise-financed R&D (BERD) and patents. Again, all African countries with the exception of South Africa are at the bottom of the table. Finally, countries in the continent are not generating and growing significant industrial activity and technological dynamism on the basis of the UNIDO Industrial Technological Advance (ITA) Index (Mugabe, 2009:10). According to the index, most SSA countries are ranked below the other developing regions of the world. The overall conclusion is that Africa is very poorly placed in terms of the basic structural requirements of building a modern KBE.

A specific concern for this study is the role of universities in industrialization. Lall and Kraemer-Mbula (2005:5-7) emphasize the role of manufacturing as ‘the main engine of structural transformation’ and outline ten reasons why it is important. Manufacturing industry is the main vehicle for application of technological progress to production. Manufacturing is the major source of innovation and the hub for diffusing innovation to other activities. Manufacturing is a vital source of new skills
and attitudes particularly in transforming traditional economic structures. Innovation and skill creation by manufacturing have large beneficial externalities for other activities. Manufacturing provides the direct demand stimulus for the growth of many modern services. The sector is associated with the development of modern institutions and legal structures that the modern economy requires. It is also the main source of dynamic comparative advantage through the shift from primary to more advanced, high value manufactured exports. The internalization of the economy often follows the spread of manufacturing. Finally, the exposure to foreign markets, enterprises, skills and practices that manufacturing brings can be the catalyst for modernisation of national industrial enterprises.

Further, for purposes of measurement of the national technological capacity, this sub-sector has a key role in the measurement of technological and skill intensity through the value-addition process, which also serves as a proxy measure of the knowledge composition of both the process and final manufactured goods. These measures are also important for determining quality and international competitiveness of the manufactured output.

A study by the AfDB (2014: 74-76) highlights global trends among the developed nations to strengthen their manufacturing sectors, especially with an emphasis on innovation. The European Union has a proposal, *A Stronger European Industry for Growth and Economic Recovery* to reverse the de-industrialization of Europe and to expand the share of industry in EU from 16.3% to 20%. Within the EU, member states also follow their own industrial policies typically phrased in terms of cluster support and innovation system terms. In the US, the Presidential Council of Advisors
on Science and Technology has tabled a document, *Capturing Domestic Competitive Advantage in Advanced Manufacturing*, which urges the government to establish a national network of manufacturing innovation institutes, to invest in community college training of the advanced manufacturing workforce, to evaluate platform manufacturing technologies for collaborative investments, and to reinvigorate the image of manufacturing in America. Several programmes have been instituted: Advanced Manufacturing Partnership; Advanced Manufacturing National Programme Office; Advanced Manufacturing Technology Consortia programme; National Robotics Initiative; Materials Genome Initiative; and a pilot institute, the National Additive Manufacturing Innovation Institute.

China has targeted a number of strategic emerging industries (SEIs) in its current 12th Five-Year Plan. To drive this, GERD stands at 1.97% of GDP with 5% of this going to basic research; the number of national engineering research institutes and other facilities has increased steeply; and the number of venture capital systems and patent applications and grants have also grown. India has adopted a National Manufacturing Policy so as to increase manufacturing’s share of GDP from 16% to 25% by 2022. Brazil’s *Plano Brasil Maior* combines an ambitious trade policy with industrial policy, with an emphasis on innovation and increasing labour productivity. Japan’s *Industrial Structure Vision 2010* outlined a range of cross-cutting policies aiming at making Japan Asia’s industrial centre and promoting enhancement and retention of key industrial capabilities. South Korea has recently developed strategies for certain flagship industries. In Australia, the *Smarter Manufacturing for a Smarter Australia*, contains wide-ranging proposals to boost the country’s manufacturing sector.
Mwamadzingo (1996:1-2) highlights the history of many regional initiatives for industrialization in Africa since the early 1970s. The continent’s recognition of industrialization as a strategy of revitalizing economic growth can be traced to the 1971 First Conference of African Ministers of Industry in Addis Ababa. In 1979, the Organisation of Africa Unity (OAU) Heads of State and Government adopted the Monrovia Declaration, the African strategy for the Third United Nations Development Decade, in which industrialization was ranked second after self-sufficiency in food. In April 1980, the Council of Ministers of the OAU formulated the Framework for a Programme of Action for the African Industrial Development Decade (1980-1990). This programme was adopted by the African Heads of State and Governments as the Lagos Plan of Action emphasizing general and country-specific commitment to promoting industrialisation as a fundamental option in the total range of activities aimed at freeing Africa from underdevelopment. They also declared the 1980s the Industrial Development Decade for Africa (IDDA).

However, in spite of these developments, the industrialization scene in Africa is not rosy at all. Lall and Kraemer-Mbula (2005:23) provide an overview of vital statistics. The share of manufacturing value-added (MVA) in global MVA for the 1980-2000 period dropped from 1.0 percent to 0.82. Without South Africa, it declined from 0.43 percent to 0.41 percent. With regard to technology, MVA is heavily biased towards resource-based manufacturing activities (RBMs). The share of medium and high technology (MHT) was very low and declined over time. With regard to export market shares, again Africa only accounts for 0.6 percent of world manufactured exports. Without South Africa, between 1981 and 1990 the share declines from 0.3 percent to 0.1 percent. On the other hand, the share of exports by East Asia in world
market shares rose from 6.8 percent in 1981 to 18.4 percent in 2000. World market shares of African exports by technology are higher in primary products and RBMs but lost in MHT manufactured products. East Asia raised its share of pure manufactures to levels even higher than industrialized countries in both low and high technology products. With regard to upgrading in the export structure, which indicates responsiveness to world trade and technology, the authors observe that Africa as a whole lags other developing countries, a scenario that contrasts vigorous upgrading in the East Asian countries. In sum, these figures show very low levels of industrial and export capabilities in much of Africa.

In its focus on 7 countries in the Eastern Africa region (Burundi, Ethiopia, Kenya, Rwanda, Seychelles, Tanzania and Uganda), the 2014 AfDB study re-echoes the importance of manufacturing as a cornerstone of development as a key driver of productivity growth, formal employment growth, innovation and technological advance and export performance for Africa. However, it decries the limited role that manufacturing currently plays in the east African region. The contribution of manufacturing to GDP has remained low, and manufacturing value added (MVA) per capita still is lower than the African average. Diversification is limited, with the share of low technology manufacturing and MHE manufacturing in regional GDP still low. The region is still heavily dependent on minimally processed resource and RBMs in export, involving relatively low value-addition and vulnerable to external price shocks. The study though observes that policy frameworks are generally well-aligned to achieving policy goals of expanding manufacturing, but there are a number of problems in execution. The countries also have a comparative advantage in some sectors-agro-processing, textiles, clothing, leather and wood products, niche
pharmaceuticals, industrial materials, assembly of advanced products that can take advantage of rapid urbanization, the emergence of a middle class, and regional integration. The study makes several policy proposals with regard to macroeconomic policies to support manufacturing, development of a competitive business environment, leveraging of FDI, investment in infrastructure, improvements in trade logistics, further development of SEZs and cluster policies, improvements in finance infrastructure for manufacturing, and specific sectors policy recommendations.

Yet in spite of this disturbing picture, Africa needs to strengthen innovation in its manufacturing sector in order to change, diversify and modernize its economic structure to make it robust and competitive. Lall and Kraemer-Mbula (2005:1) emphasize this using the experience of the East Asian ‘tigers’ experience to point out two crucial aspects of industrialization: the ability to master new technologies by mounting technological effort and to access new technologies, skills and export markets by attracting FDI in export-oriented activity. They note that national competitiveness requires cumulative effort to build a range of technological, institutional and managerial capabilities and focused strategies. This is especially crucial in the changing setting for industrialization in which technological advancements have reduced transport, information and communication aspects of transactional costs; competition pressures are breaking down policy regimes geared toward protectionist tendencies; the threshold level of skills needed for competitive production is being raised by rapid, pervasive, and persistent technical progress in manufacturing technologies; the production of technology-intensive products is growing much faster than other manufactures; and innovative products with high R&D spending are growing faster than those with slow-changing technologies. They
identify innovation and relocation to lower cost areas as the key drivers of competitive advantage. The conclusion of the study is that building capabilities that help to absorb and improve existing and new technologies will require an efficient learning system consisting of framework conditions, FDI regime, factor needs and strategic policy capability.

Reddy (cited in Goransson and Brundenius 2011:25) contextualizes the role of universities in sector-specific productive activity that builds the capacities mentioned above by observing the more prominent role of university research in agricultural than in industrial development. He cites the example of research in crop production through new varieties of seeds and disease-resistant crops, while extension services are a vehicle for the transfer and commercialization of new technologies and associated knowledge to farmers. Land-grant universities in the USA, the research-based Agricultural Company in Brazil, and the Vietnamese public research organizations, the Rice Institute of Mekong River Delta and the Institute of Southern Fruit Trees, are given as examples of platforms that have provided links between agricultural knowledge and technology and the agricultural sector, thus boosting productivity.

Reedy observes, however, the slightly different scenario with the link between the university and manufacturing industry. Among the reasons for this include the relative strength of industry in developing new technologies, the relative emphasis on basic rather than applied research by universities at the expense of industry’s interest in specific application technologies, among others. This does not rule out the role of universities in innovation as noted in such areas as chemistry, medicine and
engineering in the nineteenth century, and in the growth of new science-based technologies such as in electronics, bio- and nanotechnologies more recently. Even more instructive is his observations that universities are perceived by policymakers as essential for the knowledge economy through the link between university research and innovation on the one hand and industrialization and economic development on the other, and that university-industry linkages are critical vehicles for this.

Reedy provides a picture of these partnerships in a report on the state of art review. In leading EU member states, these links are situated in the linking of research policy into innovation policy on the one hand and the linking of innovation and national development policy. The USA ‘s Bayh Dole Act of 1980 is an example of legislation that encourages universities to own inventions made under federal funding and to become more directly involved in commercialization of these scientific outputs. The impact is that returns to expenditure on R&D are visible through innovation output. He contrasts this to the ‘innovation deficit in OECD countries. In a glance at the situation in the study countries-Brazil, China, Germany, Russia, Uruguay, Vietnam, Reedy concludes that policy consciousness on university-industry collaboration is still at a nascent stage.

Finally Reedy looks at specific micro-level measures to promote linkages between universities and industry. Examples abound in the study countries. In Brazil spin-off companies around academic research projects, business incubators, TTOs and technology parks have grown rapidly since the 1990s. In China, the government initiated ‘enterprise-university-institute co-operation’ in 1992 to encourage UILs and universities began to embrace the third mission. Cuba reformed its S&T policy in the
mid-1980s that led to the re-orientation of university research to applied research, definition of new research priorities for S&T development and the creation of STPs. Denmark’s universities have TTOs, patent offices, network centres, incubators, knowledge ambassadors, among other platforms. In China the first university STP was established in 1991 and there are STPs in 42 of its 50 universities. Cuba’s Havana West Pole made up of universities, research institutes, the healthcare system, and government operates as a biotech-based medical-pharmaceutical industrial cluster involved in R&D, manufacturing and marketing. Latvia’s NSI that supports its predominantly SMEs consists of industrial parks, technology centres, consulting companies and risk capital funds. However, only one country from Africa, Tanzania, features in this study, and the examples given are the College of Engineering and Technology, the Technology Development and Transfer Centre (TDTC), and the Tanzania Gatsby Trust.

Goransson and Brundenius (2011:4) argue that since the evolution of innovation systems in the developing world is complicated due to rudimentary or non-existent basic institutions, they have to be created on the basis of existing or emerging technologies or sectors and that in this creation process,

...universities tend to be important players, given a number of specific features, such as their potential global integration into technological and scientific networks, their tradition as relatively autonomous organizations, their relationship to international diasporas, etc. Hence, in the development process, universities are not just one of many important institutions, they are potentially one of the most important.

From the AfDB study, it is useful to note the emphasis on the role of industrial parks as SEZs where university-linked publicly funded research institutes are part of a knowledge base to encourage knowledge spill-overs and to aid the formulation of
relevant curricula. The recommendation that governments in the study countries in the eastern Africa region buy out and relocate manufacturing firms that own and apply technology but fail in their business model in the industrial park also has implications for the university. These could provide opportunities for learning and training.

In the Kenyan scene, the Government of Kenya has consistently earmarked the development of the industrial sector since independence. The key landmarks in this endeavour include: ownership of the economy at independence, promotion of import-substitution industries through government ownership of industries, linkage to domestic raw materials for employment generation and poverty alleviation, export orientation to bolster foreign exchange earnings, price competitiveness for regional markets, and concerns for comparative advantage in the context of globalisation (Kibua, 2007: 8; Ronge and Nyagito, 2000:1-9).

The two major strategies through which these endeavours have been undertaken are import-substitution industrialisation (1963-1989) and export-oriented industrialisation (1989-date). By 1997, the Government had put industrialisation as a lead engine for development, with the push initially to be driven by selected labour-intensive, resource-based and light manufacturing industries, primarily small-scale industries that use locally available raw materials and simple labour-intensive technologies and are therefore capable of generating employment. Examples are agro-based industries like: textiles; horticultural processing; skins, hides and leather; tea, coffee and sugar processing; and building and construction, such as brick manufacturing. The second phase was to target intermediate and capital goods industries that are more technology and capital intensive, including metallurgical, non-petroleum-based chemical,
petrochemical, pharmaceutical, and machinery and capital goods industries. The latter were initially expected to produce for the domestic market with the export market being their eventual goal. This approach was largely maintained in the subsequent policy framework, the ERS but altered in the existing development blueprint, the Kenya Vision 2030 (RoK, 2007).

The key argument for industrialising the Kenyan economy is best captured in Kenya’s first emphatic policy blueprint on industrialisation, *Sessional Paper No. 2 on Industrial Transformation to the Year 2020* (RoK, 1996:2-3). This policy statement is formulated in the context of poverty, unemployment, meagre foreign exchange earnings from primary commodity exports, falling real wages, population pressure on land and attendant decrease in agricultural productivity. Citing the experience of the NICs, the government sees industrialisation as the vehicle of achieving rapid and sustained economic growth and structural transformation through the utilisation of the full potential of the country’s resources to broaden the economy. The engines of this strategy are efficient industries that are internationally competitive and which utilize the latest technology.

The emphasis on industrialisation in Kenya is also echoed in Kenya’s Vision 2030 in which a part of the destiny is ‘a rapidly industrialising middle-income nation’ (RoK, 2007: ii). The manufacturing sector is expected to play a critical part in propelling the economy to a 10 per cent growth rate through ‘creation of jobs, the generation of foreign exchange, and attracting FDI (RoK, 2007: 60-65). The sector needs to be efficiency-driven so as to raise TFP even as other reforms to make the sector competitive are undertaken. The targets for the sector are strengthening local
production, increasing regional presence and developing niche products for global competitiveness. It is instructive to note that STI is envisioned to play a role through increased investment in training and R&D to build knowledge, technology and innovation. Flagship projects are the development of industrial and manufacturing zones and SME parks.

The weakness in the Kenya Vision 2030 is the failure to explicitly link STI policy to manufacturing sector policy in an explicit way that facilitates policy monitoring and evaluation. The Kenya Vision 2030 sector plan for STI identifies STI challenges and supportive strategic technology platforms for the manufacturing sector among others. It also outlines 7 strategic thrust areas, 3 that are of interest in this study: strengthening technical capacities and capabilities, developing highly skilled human resources, and intensification of innovation in priority sectors. In each of these areas, there is an appreciation of the need for the involvement of stakeholders in a triple helix of universities, manufacturing industry players and the government.

However, three gaps need to be pointed out. First, there are no systematic studies that report the capacity of universities to meaningfully participate in facilitating the implementation of this STI agenda. Are they third-mission oriented to satisfactory levels and, if so, to what extent? Secondly, sustainable industrialization in Kenya can only be driven by an indigenous industrial base that is constituted by local enterprises. These enterprises, however, are largely in the informal sector and faced with numerous survival challenges. The STI and industrialization policy frameworks recognize this, but it is not evident if universities have the capacity and platforms to interact with the SMEs. Finally, the STI innovation policy and plan fails to be linked
in the Ministry of Industrialization's priorities identified in the manufacturing sector targets in the Kenya Vision 2030 (RoK, 2008:10). Thus, there is no means of tracking implementation of the STI's M&E plan to MoI's one.

But it is especially the lack of systematic country-specific empirical studies on the relationship between the university and sector-specific innovation on the one hand and the mechanisms of knowledge transfer to the manufacturing sector and the effects in terms of the evolution of a KBE in Kenya that is of special interest for this study. To appreciate the magnitude of this omission, it is necessary to understand how the university is an agency in the development of a KBE in general and knowledge-based industrialization in particular. It is to this aspect that the review of literature now turns to.

2.4 University-Industry-Government Linkages, Innovation and Knowledge-Based Industrialization

As noted earlier, the transfer and use of knowledge and technology for a KBE in general and knowledge-based industrialization in particular is at the heart of the definition of innovation and constitutes the essential mission of the modern science system. As has been emphasized in the previous section, the scenario in developing countries such as Kenya requires universities to play such a key role in driving manufacturing sector-specific knowledge generation, transfer and diffusion as midwives for technological development in the relative absence of high technology-based firms and private sector based BERD, and also since they are main centres of research activity. Such a university must be entrepreneurial in nature and orientation. This section begins by highlighting the nature and roots of the entrepreneurial university in particular science and university system philosophies, approaches and
culture. The institutional aspects of the entrepreneurial university are then addressed. Finally, the roles of the other elements in the innovation sphere are then examined.

2.4.1 The Science System Governance Roots of the Entrepreneurial University

The proposal to adopt the entrepreneurial university approach can only be understood in light of particular roots in research governance. There are 3 models based on the experience of macro-governance of the science system and its relation to political and economic systems: the Anglo-Saxon model, the Continental Europe model and the hybrid Nordic model (Benner cited in Goransson and Brundenius, 2011:13-22).

According to Benner (cited in Goransson and Brundenius, 2011:14) the US economic growth model, upheld as a role model and responsible for its economic prosperity and innovation dynamics, has been built

...upon the combination and concentration of advanced technology, talented people, social diversity, resources that are highly dependent on universities, in combination with public and private actors with complementary resources.

The US research system is characterised by a concentration of talented scientists in a small number of leading knowledge and innovation centres, further reinforced by the concentration of support from the dominant funding agencies. The leading institutions, especially universities, have reinforced their position in the research system through aggressive managerial practices that entail recruitment of leading scientists, large endowments and a strong position in a highly stratified funding system. The other elements of the science system are the research laboratory system, National Institutes of Health, and the Departments of Energy, of Agriculture and of Defence. The US political economy, a liberal market economy, is characterized by
few strong binds between actors and organizations, a large degree of flexibility based on the flexible deployment of resources, a vigorous capital market, and a vivid culture of entrepreneurialism. Benner (cited in Goransson and Brundenius, 2011:15) concludes thus:

The mechanisms of integrating the research system with the market are, therefore, exceptionally well developed in the USA if compared with that in the European countries. First, the universities are often based in an entrepreneurial tradition and are accustomed to operating according to market or quasi-market conditions. Second, academics have historically been subject to many incentives to combine traditional academic tasks with entrepreneurial activity, without necessarily having to depart from their academic positions. Third, the infrastructure for science-based entrepreneurship is highly developed, with a rich flora of venture capitalists, organizational brokers, university patenting, and licensing organizations surrounding the academic centres. As a result, the research system has emerged as an integral part of the development, dissemination, and exploitation of new knowledge. Key aspects in this institutional set up include the mobility of scientists, the amount and scope of policy initiatives to support academy-industry linkages, the openness of research organization to scientific change, and the importance of integrative mechanism between academics and entrepreneurs.

In Continental Europe, Benner (cited in Goransson and Brundenius, 2011:21) observes that universities function as primarily academic organizations with a tradition of rigid career structures and professorial hierarchies. Research institutes are the dominant organizations for basic and applied research. Universities perform less research, and there is minimal collaboration between them and other public research organizations, a role left to larger firms. The applied research institute sector has rich ties and networks with existing industrial strongholds. With the exception of Netherlands and Sweden, the university system is inflexible, segmented and overloaded so as to be unable to provide strong infrastructure for research excellence. Benner concludes by observing that in these countries, the strengthening of
universities and academic research is seen as a necessary part of the reform of the innovation system.

Benner notes that in the Nordic model the two models discussed above are combined. From the Anglo-Saxon model, their research governance system has a strong position for universities through concentration of resources to fewer, high profile institutions in growing research areas, and strong ties between the research system and high technology firms. Like the Continental Europe model, there is a strong public support of research areas with connections to low-technology industries and mature industrial field such as food, engineering and transport, as well as major investments.

In the three models, research governance has converged around a pattern of resource concentration with universities increasingly becoming the most important instrument for securing a position in the globalized knowledge-based economy by securing scientific visibility and by fostering networks of innovators and innovating sectors around them. Outside these models and examples, most countries have fostered leading national universities though they are not always the focus of research activities or known for broader roles in economic development. Some of these universities are too large to be responsive to reform.
2.4.2 The Entrepreneurial University in the University-Industry-Government Linkage

In the context of a KBE, what, then, is an entrepreneurial or third-mission university? What makes it different from a traditional one? Etzkowitz (2004: 64-77) has elaborated on the concept of an ‘entrepreneurial university’, a term first brought to public attention by Burton Clark in 1998 (Williams, 2007:4). Academic entrepreneurship, Etzkowitz (2004:65) states, is the extension of teaching and research activities and the internalisation of technology transfer capabilities, thus taking the role of the capitalisation of knowledge traditionally played by the industry. He observes how the entrepreneurial university emerged from medieval roots as a conservator of knowledge and transmitter of knowledge to being its originator it and then putting it into use through the working out of an inner logic of academic development. The defining characteristics of such a university are: capitalization of knowledge, interdependence through close interactions with industry and government, independence, hybridisation, and reflexivity.

Etzkowitz also refers to this academic development as a ‘revolution’ which has occurred in three phases. The first one took place in the late 19th and early 20th century when research became a legitimate function of the university and resulted into the birth of the modern Humboldtian university which emphasized the interconnection between teaching and research. Teaching and research had previously developed separately in colleges and scientific societies. The second academic revolution saw another expansion of the university missions, this time from teaching and research to the capitalisation of knowledge. In fact, the inner logic is visible in the fact that the first academic revolution sowed seeds for the second by providing the research base
from which results with practical implications could be applied to economic and social development.

This has inevitably led to the development of university-industry relations. These range from informal activities to formal mechanisms that package knowledge and technology into discrete sets of rights and advance the exploration of its commercial potential. *Informal* transfer of knowledge can occur through *consultancies, faculty-student relationships* and *publications*. Players in industry can also formally access technology from the university through various points: direct access to *research groups*, mediated access through a *liaison office* (ILO) and *technology transfer office* (TTO), and through *incubators* (Etzkowitz, 2004). Wu (1997) adds *general support, contract research, research centres and institutes, research consortia, industrial associate/affiliate programmes*, and *research parks*. *Staff exchange and joint curricula development* are yet other forms (Ssebuwufu, Ludwick and Beland, 2011:4). Hernes and Martin (2000:21-22) observe that in industrialized countries research-related university-industry linkages are the norm, while consultancies, student placements and continuous professional development are more likely.

Etzkowitz describes the progression in the process of technology *transfer*. Beyond *producing graduates and publications*, the first step in taking knowledge out of the university begins with a *liaison office*. Such an office facilitates contacts, thus formalising the process by which firms may make their own contacts. Further, a liaison officer can organize interactions between a department or research unit and interested firms. In the next stage, knowledge is encapsulated in a *technology* and moved out by a *technology transfer office* created to identify, patent, market and
license intellectual property (IP). It pulls technology out of the university and finds a place for it. In the third stage, knowledge and technology is embodied in a *firm* and moved out of the university by an entrepreneur. Firm formation initially began through the invention of the venture capital firm in the late 19th century at Harvard and MIT. The *incubator* was introduced during the 1980s at Renssellear Polytechnic Institute. It is a formal organisation providing space and other assistance to nascent firms emanating from academic research (Tura and Bishop cited in Howlett, 2010:285-288).

Mitchell and Reedy (2007:32) illustrate the classic process of technology transfer at a research university as shown below:

![Figure 2.2: The Linear Model of Innovation](image)

**Source:** Rogers, E., Yin, Y. & Hoffmann, J. (2000). *Assessing the Effectiveness of Technology Transfer Offices at US Research Universities, Association of University Technology Managers*

Wessner (cited in Nordfors, Sandred and Wessner, 2003:55) describes the non-linear model of innovation as consisting of four basic elements: basic research, applied research, development and commercialization. However, the links are iterative and not linear. *Basic research* is provoked by news, knowledge, fundamental ideas and is driven by a quest for basic understanding. *Applied research* is based on the potential
use of the outcomes of basic research, and consists of application of the knowledge of a specific subject, i.e. ‘prototypicalization’. The process of developing products (goods, services) from applied research is called \textit{development}. In the course of doing so, new unanticipated applications may emerge and are included in the development phase. After that, the product is introduced in the market, i.e. \textit{commercialization}. The feedback loop kicks in at this point. Due to market signals or a technical challenge, there arises desired alterations to the product or the development of a product with new characteristics. This leads back to the development phase, where applied research is needed to design new product characteristics. In turn, there arises need for new ideas and solutions to solve longer-term issues, hence the need for basic research to discover these ideas and explore new solutions.

Etzkowitz illustrates the diffusion of the entrepreneurial academic model in the USA, Sweden and Europe, and Brazil. In the USA, academic-industry relations developed during the 1970s and 1980s in response to increased competition. The incremental evolution of products within existing firms was inadequate to ensure economic growth, and academia was therefore brought into a new alignment with industry. This facilitated the introduction of new technologies into existing industries and the creation of new firms based on new technology. In Sweden, the entrepreneurial university was based on teaching through introduction of entrepreneurial training into the curricula. These training programmes are designed to create firms as well as educate students in the new discipline. Students are expected to play the entrepreneurial role in taking research out of the university and turning it into firms. For example, the Entrepreneur Centre at Linkoping University produces 100 spin-offs annually from its training activities and through extension of its programme at other
Swedish universities. Students move from courses into pre-incubator facilities where they turn their ideas into business plans, and the best students then invited into the incubator often with pre-arranged funding.

In Europe, the EUREK project is a European Commission project that studies the internal workings of universities and how government policy can affect knowledge production processes. It explores the dimensions of entrepreneurialism in a cross-section of universities in seven European countries: Finland, Moldova, Poland, Russia, Spain, Sweden and the United Kingdom. Williams (2007) observes that in general, financial stringency and financial opportunities were the main drivers of entrepreneurial activity in the study universities in the EUREK project. Williams reports that in the EUREK study, Nottingham University in the UK was the most entrepreneurial and was able to embark on ambitious ventures because of its sound financial ventures. He continues to observe that although British universities had moved further in the entrepreneurial direction than those in other EUREK countries, those in Finland and Sweden have become more financially adventurous since the mid-1990s. He concludes that entrepreneurship within universities is encouraged through the following: allocating extra income to those who have the ideas, who take risks and who do the work; a significant number of academic staff that accept a commercial culture; the regulation of unofficial freelance ventures; and a university that is active in subject areas where professional development and research findings are commercially and socially valuable.

Ebong (2004:558-570) details mechanisms used to engender university-industry relations in three Commonwealth countries: Australia, Canada and the UK. In Australia, the establishment of university-industry linkages was a joint effort by
universities, industry and government and goes back to the 1980s. They include the Teaching Company Scheme, the University-Industry Forum, and the establishment of key centres of teaching and research. The objectives of these mechanisms were the improvement in the quality of teaching and research, the generation of supplementary resources and the search for additional legitimacy. In Canada, linkages between universities and industry are strongly encouraged by the federal and provincial governments. The mechanisms of interaction include the University-Industry Forum, the Co-operative Education Forum, the Centres of Excellence Scheme, Centres of Entrepreneurship, an Innovation and Commercialisation Fund and the University Research Incentive Fund. In the UK, efforts to encourage these interactions were already established in the 1980s and included the Teaching Company Scheme, the Enterprise Programme, and the Graduate Gateway Programme.

In Taiwan, university-industry interactions got the approval of government in the 1980s (Wu, 1997). The author reports that these relations were not allowed earlier, and therefore the universities were not a major source of innovation. The government now has enacted industrial technology policies, has set up research institutes, and attracted scholars and engineers from abroad to return to the country. The author cites examples of the Tze-Chiang Foundation of Science and Technology as an intermediary organisation, the National Science Council’s University-Industry Research Co-operative projects, and the incubator programmes under the Ministry of Economic Affairs’ Small and Medium Enterprise Agency. This has led to the development of high-tech industries. The government, universities and industry continue to learn on how innovation proceeds on the basis of interactions among them.
Intermediary structures help to match-make researchers in the universities and users of technology. Such interfaces have helped develop or adapt technologies for commercial viability, pooled lab facilities for firms to access otherwise unaffordable equipment, and mobilised resources for scholarships, to fund specific research projects and incubators (World Bank, 2009:62). Examples given of such structures include WARF in the USA, the *Steinbeis* Foundation and *Fraunhofer* Institutes in Germany, *Spinnoes/Tekes* of Finland the Technology Advanced Metropolitan Area in Japan, the *Tze-Chiang* Foundation of Science and Technology in Taiwan, the Council of Scientific and Industrial Research in India, the Malaysian Agricultural Research and Development Institute in Malaysia and the *Fundacion* in Chile, among others.

How has the concept of the entrepreneurial university evolved in the context of developing countries? Most universities in Africa face considerable internal constraints such as low institutional capacity for research and external ones such as unsupportive economic and political environments. They are also accused of churning out graduates and research that are irrelevant to the needs of employers and the challenges facing their economies (Ssebuwufu, Ludwick and Beland, 2011:4). This state of affairs is attributed to several factors among them the colonial and post-colonial origins of the university system; the previous relative neglect of the university sub-sector in rates-of-return driven debate in the development discourse; the adverse effects of the SAPs on social sector spending, including education but especially the apparently socially unprofitable university sub-sector; the largely uneasy and often antagonistic relationship between African governments and universities, brain drain, among others (Naidoo, 2008:1; Etzkowitz and Dzisah, 2008:7-8; World Bank, 2009: 1-2).
In spite of this bleak picture, there is ongoing re-conceptualisation of the role of African universities and corresponding measures to support linkages with the productive sector (Ssebuwufu, Ludwick and Beland: 6). There are efforts at a regional level to foreground the role of universities in African’s development agenda through university-industry relations. Examples are the AAU-AUCC’s SHESRA project supported by CIDA developed in April 2010 in which university-industry linkages receive emphasis as a way of strengthening African higher education links with the education sector (Ssebuwufu, Ludwick, and Beland, 2011:8). The ADEA 2012 Triennial’s Transnational Thematic Study sub-theme is appropriately titled *Strengthening Linkages between Industry and the Productive Sector and Higher Education Institutions in Africa*. Another initiative is by the public Catalan universities belonging to the Associacio Catalana d’Universitats Publiques and African universities that belong to the Interuniversity Consortium of University Management. It has led to the development of a practical guide on innovation and knowledge transfer in Africa (ACUP-CIGU, 2013).

With regard to interface platforms to bring the universities and industry in Africa, there are some initiatives. For example, AAU-AUCC (2013:37-43) observe that the adoption of science parks and business incubators is a recent phenomenon in Africa. The earliest science parks were established in 2005 while the earliest business incubator dates in 2008. There is no comprehensive database or directory of science parks and business incubators in the continent in general and for universities, and only 2% of the 385 members of the International Association of Science Parks (IASP) worldwide are from Africa. A survey of such intermediary organisations revealed the following:
i. The government was the greatest instigator of business incubators, while universities were the main proponents of science parks;

ii. Most business incubators were stand-alone units with very few based in existing science parks, only 20% were based in universities while 60% of science parks were university-based;

iii. Once science parks and business incubators were launched, the private sector tended to get more involved, although at very low levels. Thus 70% of these structures were publicly owned;

iv. The most usual objectives for science parks were the creation of new technology-based firms and promotion of local economic development. Enhancing university-industry linkages only featured modestly as an objective. Almost all of the units housed R&D activities;

v. Attracting foreign companies was an important objective of the surveyed science parks;

vi. Half of the science parks were based in large cities, 70% were based in medium-sized ones while 84% of business incubators were in medium-sized cities.

A SHESHRA Technology Uptake Survey study done in 2012 found that university faculty and students were the most frequent entrepreneurs at the business incubators (AAU-AUCC, 2013:40). These incubators had relatively few incubated companies and most had fewer than 10 incubates. Technology-based firms in the incubators which focused on commercialising the technologies they developed were common. The units also housed R&D labs of established firms and academic R&D facilities. In
terms of management, most science parks and incubators operated as semi-autonomous entities with their own boards and management.

With regard to spin-offs from universities, these are a very recent phenomenon in Africa (AAU-AUCC, 2013:42-43). These ventures are usually founded by university researchers and/or students with the purpose of transferring scientific and technical knowledge generated within the university. These firms were mostly found in North and South Africa. Universities in Sub-Saharan Africa are only beginning to embark on the commercialization of knowledge and technology and not many examples of spin-offs have been documented. This is also seen in the fact that the continent has very few commercialised patents (AAU-AUCC, 2013:49).

A general assessment of the status of university-industry linkages in SSA by the World Bank also reveals some level of interaction with the industry (World Bank, 2009:44-48). These have taken various forms. For example, in Kenya Maseno University and JKUAT offer courses customised to the technical needs of the horticulture industry. Others have required students to undertake internships to acquire practical knowledge and requirements of industry back to universities. Faculty members engage in consultancies both informally and formally. Still others such as JKUAT in Kenya have set up ILOs to handle patents (Ng’ethe and Ngome, 2006:22-23). Other intermediary organisations in universities offer opportunities for networking and exhibition to inform industry of the availability of research conducted at universities and available technology. In a few instances, universities are producing capital goods to fill voids in the marketplace. Examples are the production of lantern
parts for small local businesses, fresh juice making machines and development of software packages for accounting and real estate management firms, all at JKUAT.

While the first part of this section illustrated global trends in the development of the entrepreneurialism in the university sphere, there is need to pay attention to structural dimensions that undergird the entrepreneurial spirit. The ACUP-CIGU (2013:50-52) highlights pertinent areas for the university. These cover three areas: a favourable institutional environment, capacities and financing. The aspects of a **favourable environment** include:

i. Institutional strategy explicitly incorporating research and technology transfer into the productive environment as one of the university missions;

ii. Institutional strategy that determines the priority strategic areas of research, development and innovation (RDI) backed by specific scientific capacities;

iii. Mechanisms for assessing and following up university efforts in knowledge transfer;

iv. Adoption of the institutional strategy by the highest the university’s highest governing body and disseminated to the university community;

v. Mechanisms to facilitate the identification and protection of knowledge, research results and technology, and of their licensing to companies. This should include internal regulations on the management of IPR that favour and promote inventive activity and knowledge transfer of university staff, prevent conflict of interests and describe division of net benefits derived from its exploitation;

vi. Clear assignment of responsibility for managing the transfer function as well as mechanisms to assess and monitor the efforts of the transfer unit;
vii. Incentives to the university staff RDI activities based on evaluations by means of defined procedures, and these procedures should allow for analysis of the quantity and quality of their output, e.g. number of publications indexed, co-authorship, H-index, number of quotes, etc.; as well as for the analysis of the transfer activity, e.g. patent applications, income from patents being exploited, creation of companies, etc.

viii. Active policies that facilitate the collaboration of university staff with the economic sector through execution of consultancy contracts, technical assessments, contract/collaborative research; and active policies that promote the creation of technology and knowledge-based companies by university staff;

ix. Internal regulations governing the participation of research staff, visiting lecturers in RDI activities especially on confidentiality and rights to research results; on prevention of conflicts of interest of university staff in their relations with the private sector; and on the creation of knowledge- and technology based companies by university staff;

x. Programmes that promote and facilitate the incorporation of researchers into companies;

xi. Mechanisms of public-private collaboration;

xii. Mechanisms of stable relations between the university and government that permit knowledge transfer mechanisms to be dealt with and debated; and mechanisms of stable relations between the university and the business community;

xiii. Relations with private investment entities (for seed capital, business angels, venture capital) and financing (banks).
Those that deal with **institutional capacity** include:

i. Staff contracted to do R&D activities;

ii. Human resources with training and experience dedicated in managing research and knowledge transfer;

iii. Teaching staff specifically trained in transmitting knowledge in entrepreneurship;

iv. Stable research structures such as research groups and research centres;

v. Programmes to promote internationalisation of teaching and research;

vi. Programmes for hunting and retaining talent based on criteria of excellence and in line with priority RDI areas; programmes for training entrepreneurs; programmes for training SME staff;

vii. Management procedures and tools for notifying about inventions and their dissemination; for appraising results of research (analysis of patentability, market studies, competitive advantages); for commercialising the technological and knowledge; for creating awareness in the university community about knowledge transfer and entrepreneurship activities;

viii. Stock of knowledge and patents;

ix. Collaboration with the business community in training entrepreneurs.

Finally, those that deal with **financing** include own financing programmes for R&D activities of research groups, for financing the appraisal and commercialisation of the research results, an instrument for the participation of the university in the spin-off companies created, and programmes to offer economic support for the growth and internationalisation of spin-off companies, and programmes.
AAU-AUCC (2013: 43, 48) add to this a list of what they call ‘external and internal determinants of success in regard to knowledge and technology transfer: commitment of university leadership; administrative capacity to assist early-stage companies; full-time support staff independent of the university; a good match between the research strengths of the university and tenant recruitment; a local and regional market for tenant technologies; acceptance by the local economic development community; access to capital for infrastructure; access to investment capital sources for science park tenants; physical proximity to an industrial or business centre; proximity to university campus (if outside a university); and the presence of a corporate or government anchor tenant to enhance visibility, among others. Issues of IP and the leadership of research management also feature.

Cloete and Bunting (2013:8, 43-44) emphasize academic capacity, which includes number and proportion of academics with doctorates and research capacity; ability to attract good undergraduate and postgraduate students; ability to engage business, communities and government in research; and affiliation to international academic and funding networks. Tantiyaswasdikul (2013) discusses the relationship between IPR policy and university technology transfer output in Canadian universities and notes that institutional IPR ownership policy tends to produce more new licenses and patents while inventor IP ownership policy can generate more spin-off companies. Sparrow (cited in Howlett, 2010: 73, 76) emphasizes such university capacities as research capability, branding of the university, specific measures to support innovation (specialised research units, joint co-operative ventures, interdisciplinary projects, evaluation research, etc.), and the relationship between the university and the regional innovation system. Sulo, Kendagor, Kosgei, Tuitoek, and Chelangat (2012)
emphasize the role of researcher qualifications, the research environment, funding and time availed for research.

Grobler and van Niekerk (cited in Howlett 2010: 132) add other critical success factors. There is need for a management framework that protects the university’s core as a knowledge generating and disseminating institution and that supports activities that are aligned with and strengthen its core functions, that guarantees its scientific and financial sustainability, and that reinforces its reputation among all its stakeholders. There should also be a supportive structure that requires top management commitment; inclusion of commercialization aspects into the university’s strategic plan; decisive decision making; sound governance within the university; university-wide management of university assets; reforms in reward systems; development of a sound business plan; a clear identification of IP ownership; independent financial auditing; establishment of clear commercialization outcomes and direction including legal and financial aspects; and adequate financing from industry and government. The university’s interests should be protected by appointing suitably qualified internal and external directors to represent its interests on the boards of companies in which the university has interests, according to the relevant shareholders’ agreements. The risk involved in commercialisation should be mitigated through risk management tools. There is also need for appropriate quality systems and practices for its commercialisation processes.

From this review, it is evident that there is also need for systematic empirical studies on the extent of entrepreneurialism in Kenyan universities and the extent to which these support structural conditions that support such entrepreneurialism especially
within the context of the development of knowledge-based industrialization. But in order to triangulate the absence of a triple helix perspective in the Kenyan innovation scene, it is necessary to examine the role of national governments. It is to this that we now turn to.

2.4.3 Innovation, University-Industry-Government Linkages and Government Policy

Government support for commercialization of knowledge and technology to the productive sector has been considered very key to the success of innovation, and has been evident in many innovation strategies in both developed and developing countries. Such support needs to be seen in the context of the importance attached to STI in economic growth and structural transformation, international competitiveness and of the growing significance attached to higher education in development. Martin (2000:1,4) observes that the issue of university-industry partnerships has become prominent on policy-making agenda in many countries as governments become increasingly aware of the importance of HEIs as 'strategic actors' in national and regional economic development. This is evident in the formulation of STI policies in many countries, efforts to increase allocations to R&D as a proportion of GDP, policies to promote STE education, and interventions to reform the higher education scene, among other initiatives. Juma and Yee-Cheong (2005: 1-12) argue for combining industrial, STI and education policies. A brief glance at empirical literature on the role of government can illustrate the trends in the components of innovation policy and strategies for its co-ordination for development.
In OECD countries, Gault (2010:88-103) reports that there is a joint cross-government policy approach, dubbed the *OECD Innovation Strategy*, initiated by the OECD Council of Ministers. As ‘an important source of policy guidance for boosting productivity, competitiveness and growth as well as for harnessing innovation to address global challenges’ the Strategy focuses on 5 core aspects: markets, people, innovation activities, public institutions, and international engagement. Aspects of the **market** include brand recognition, lead market, competitive engagement, and financial services. Aspects of the **people** component include characteristics of the labour force, demographics and the demand for innovation, and migration. **Innovation activities** include technology and practices, user and user-driven innovation, open innovation, and demand-driven innovation. **Public institutions** include infrastructure, procurement, priority setting, standard setting, public finance, direct government support, education/training and research, health, and monitoring and evaluation. **International engagement** consists of ‘Big Science’, international cooperation and development, and global challenges.

In its first summary interim report to the OECD Council in 2009 on the *OECD Innovation Strategy*, the report emphasizes the following: whole-of-government policies for innovation; importance of co-ordination of policy across government departments; co-ordination and co-operation in innovation activities in the private sector; co-ordination along value chains, within networks (e.g. producers, suppliers, users); co-ordination of knowledge markets; people issues such as education, training, life-long learning, soft skills to interact within networks, communication; firm-level issues such as importance of intangibles to innovative capacity, entrepreneurial activity and support, organizational and managerial innovation; framework conditions
such as demand for innovation and the role of procurement, competition and trade policy, policy learning; the need to bring innovation policy into development policy in a coherent way; additional collection and use of internationally comparable data at the firm level; and promoting a better understanding of currently unmeasured factors in the innovation process needed to understand the complexity of innovation.

Since OECD is merely a policy advisory body whose member countries are not bound to implement, these members have their country-specific innovation strategies (Gault, 2010: 118-129). Examples include: *Strategy for Denmark in the Global Economy* for Denmark; Finland’s *National Innovation Strategy; The High-Tech Strategy for Germany* and *Strengthening Germany’s Role in the Global Knowledge Society* for Germany; *The Netherlands: Land of Enterprise and Innovation* for Netherlands; the 2008 *White Paper on Innovation*, the 2008-2013 *Research Strategy*, and *New Industry New Jobs* in the UK; the 2007 Canadian S&T strategy dubbed *Mobilizing Science and Technology to Canada’s Advantage*; the *Japanese Third Basic Plan, 2006-2010* from the Science and Technology Basic Law of 1995, *Innovation 25* and *Science and Technology Diplomacy* for Japan; and the USA’s *A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs* of 2009.

In EU countries, the Commission of the European Communities (CEC) sets out the *EU Innovation Strategy* containing the components of an innovation strategy and the need to co-ordinate through a multiple stakeholder involvement. It brings together 10 action points that were part of the *Lisbon Strategy* for growth and jobs, 9 priorities from the *Competitiveness Council*, 6 topics on which there is on-going work, and the
European Innovation Plan accompanied by a proposed European Innovation Act. The ten action items are:

i. Establishing innovation friendly education systems;

ii. Establishing a European Institute of Technology;

iii. Working towards a single and attractive labour market for researchers;

iv. Strengthening research-industry links;

v. Fostering regional innovation through the new cohesion policy programmes;

vi. Reform of R&D and innovation state aid rules and provide better guidance for R&D tax incentives;

vii. Enhancing IPRs;

viii. Digital products and services-copyright levies;

ix. Developing a strategy for innovation friendly ‘lead markets’; and

ox. Stimulating innovation through procurement.

The 9 priorities for innovation action at the EU level from the Competitiveness Council include: an IPR framework; standardization in support of innovation; public procurement in support of innovation; Joint Technology Initiatives; boosting innovation and growth in lead markets; enhancing closer co-operation between education, research, and business by establishing the European Institute of Innovation and Technology (EIT); regional innovation through cluster promotion; innovation in services; and facilitating risk-capital markets. In addition to these priorities, the 6 topics in which work is on-going are: regional innovation; design and creativity; state aid; knowledge and technology transfer; eco-innovation; and skills.
Williams (2007:4) reports that in 2003 European heads of governments agreed to encourage universities to make a major contribution to the knowledge economy and society, and innovative entrepreneurial initiatives are an important feature of this. Williams deduces from the Europe experience that governments can stimulate entrepreneurial behaviour of universities through their resource allocation mechanisms. Governments should promote and support ‘third mission activities.

In the US, the US Department of Commerce and the National Advisory Council on Innovation and Entrepreneurship (NACIE) is currently supporting innovation and entrepreneurship targeting 5 focus categories: promoting student innovation and entrepreneurship; encouraging faculty innovation entrepreneurship; actively supporting the university technology transfer function; facilitating university-industry collaboration; and engaging with regional and local economic development efforts (US Department of Commerce, 2013:10-14). President Obama in 2011 issued an Executive Memo on Accelerating Technology Transfer and Commercialization of Federal Research in Support of High Growth Businesses.

Ebong (2004:565-566) observes that government support played a pivotal role in Australia, Canada and the UK through a long-term commitment to university-industry co-operation. In these countries, governments actively promoted interactions and had well articulated policies for national R&D. In the UK and Australia, the governments funded research through the Research Councils: the Science and Engineering Research Council, Economic and Social Research Council, the British Academy; and the Australia Research Council. Direct government support for technology-based economic development took the form of the Teaching Company programmes in Canada and the UK, and of the Centres of Excellence and Centres of Entrepreneurship
in Canada. Governments have also put pressure on universities to be more efficient and effective in the utilisation of facilities and in the management of plants, equipment and research resources. In fact, the cut-backs in public funding to universities in these countries became a driving force for a search for other forms of support such as through university-industry linkages.

Germany has a long tradition in government interventions in STI (Kuhlmann, 2003:132-4). From the 1970s, public initiatives have aimed at stimulating the innovative behaviour of industrial enterprises. The spectrum of instruments available range from institutional support for research facilities, various forms of financial incentives for research and experimental development in public or industrial research laboratories, creation of an ‘innovation-oriented infrastructure’, such as institutions and mechanisms of technology transfer. This is shown in Table 2.5:
Table 2.5: Instruments of government research and innovation policy in Germany

<table>
<thead>
<tr>
<th>Instruments in the narrow sense</th>
<th>Instruments in the wider sense</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Institutional support</strong></td>
<td><strong>4. Education, training and further education</strong></td>
</tr>
<tr>
<td>• National science centres</td>
<td>• Schools, HEIs, enterprises</td>
</tr>
<tr>
<td>• Max Planck Society</td>
<td>• Evaluation of innovation policy</td>
</tr>
<tr>
<td>• Fraunhofer Society</td>
<td>• Technology assessment</td>
</tr>
<tr>
<td>• HEIs and other institutions</td>
<td>• Long-term visions</td>
</tr>
<tr>
<td><strong>2. Financial research and innovation incentives</strong></td>
<td><strong>5. ‘Discursive’ measures</strong></td>
</tr>
<tr>
<td>• Research programmes</td>
<td>• Evaluation of innovation policy</td>
</tr>
<tr>
<td>• Co-operative projects</td>
<td>• Technology assessment</td>
</tr>
<tr>
<td>• Innovation programmes</td>
<td>• Long-term visions</td>
</tr>
<tr>
<td>• Venture capital</td>
<td>• Awareness measures</td>
</tr>
<tr>
<td><strong>3. Other infrastructure and TT</strong></td>
<td><strong>6. Public demand</strong></td>
</tr>
<tr>
<td>• Information and advice for SMEs</td>
<td></td>
</tr>
<tr>
<td>• Demonstration centres</td>
<td>• Industry and competition policy</td>
</tr>
<tr>
<td>• Technology centres</td>
<td>• Regulatory policy, e.g. influencing private demand</td>
</tr>
<tr>
<td>• Co-operation, networks</td>
<td>• Social policy</td>
</tr>
</tbody>
</table>


In China, the construction of its innovation system is driven by the government as part of its policy to introduce a market-based economy and a knowledge-based society (Leydesdorff and Guoping, 2000:4). The authors report that this has happened through three phases. The 1978-1985 phase emphasized the institutional reconstruction of the S&T system and human resource management as part of a programme in modernisation and economic reconstruction. The 1985-1991 phase consisted structural and institutional adjustments within the S &T system to the
exigencies of market forces. Competition was introduced and institutions re-aligned to enhance performance. In 1986, the High-Tech Research and Development Programme was launched, the first incubator in 1987, and the Beijing New Tech Development Trial Zone as the predecessor to the Zhongguancun Science Park soon after. Relations between the institutional spheres were established, such as liaison offices. The third phase was proclaimed in 1992 where the functions of the state and its apparatus are reshaped to support market-led economic development. Research institutes previously under ministries have become enterprises. New science parks are being certified at university campuses.

Mok (2008:3) also details how the government is assisting Chinese universities to be globally competitive. This is being done through the following: funding to improve teaching and research facilities; subjecting some to international competition for research performance (e.g. Beijing and Tsinghua); establishing intermediary bodies to link Chinese research institutes with international centres (e.g. College of Government and Public Affairs' Social Welfare and Social Policy Institute at Sun Yat-Sen University), among others. Rao, Piccaluga and Meng (2012) also add the regional development dimension by relating government R&D funding, R&D projects (e.g. programmes 863 and 973, the National S&T Pillar programme, National Natural Science Foundation programme) to the number of and revenues from patent technology transfer activities of Chinese universities.

Government support for university-enterprise partnerships require a series of integrated actions which include effective administrative frameworks, general R&D policies and more targeted programmes to encourage collaborative activities (Martin, 2007:6). Using the examples of China, Poland and the Republic of Korea,
Martin identifies a pattern in public sector response in these countries. First, the R&D is strengthened through the creation of targeted programmes for allocating R&D resources. Incentives for joint R&D efforts are given through specially-created funds from which both enterprises and universities can draw resources for collaborative activities. This may also involve the creation or restructuring of joint R&D centres. Next, support is provided to innovative enterprises through incubators. Finally, administrative frameworks that allow universities to use funds flexibly and legislation that allows universities to exploit their research results are instituted.

Of course the government has an equally important role to play in enhancing other parts of the innovation environment such as through infrastructure development and economic and industrial policies. They encourage investments in platform technologies with broad applications in the economy such as ICT, biotechnology, nanotechnology, and new materials. They also recommend public investments in infrastructure, the promotion of business activities in STI, improvements in mechanisms of advising governments on STI, and instituting mechanisms for managing global technology.

In a cross-country comparison of innovation policy, Mani (2004:39-44) examines the structure and content of innovation policy in Brazil, India, Israel, Malaysia, Singapore and South Africa. The focus is on the relative importance attached to the use of fiscal and non-fiscal instruments. The author commends Singapore's approach which starts with the creation of a pool of technically trained personnel who would emerge as techno-entrepreneurs and skilled workers in other firms. The government simultaneously encourages positive spill-overs from FDI. Only when the critical mass
of technically trained human resource is developed are fiscal incentives such as grants and tax incentives put into operation. Figure 2.3 shows the sequencing of innovation policy in Singapore, a model that could be adopted by especially developing countries.

Figure 2.3: Sequencing of Innovation Policy in Singapore

In countries with less developed economic systems, government intervention has more impact than the private sector (OECD, 2005:137; Martin, 2007: 6). This is because in light of the serious constraints faced in the economic front and those facing
universities, very little R&D can actually take place, for example. Although measures exist to try and privatise the public sector, the state remains the key driver of economic development. Martin concludes that in such circumstances, government-initiated mechanisms for enhancing university-enterprise partnerships are important to bring the productive sector into joint projects with university teams.

In conclusion, then, the role of government can be summarized to cover the following areas: creating a favourable environment, enhancing capacity, and financing (ACUP/CIGU, 2014:44-46). With regard to a **favourable environment**, the following areas are key: an explicit STI policy in the national development plan and in annual budgets; multi-annual research and innovation plans; specific government positions promoting research, technology transfer and innovation; policies promoting dissemination of freely accessible capacities in research and innovation; support system for commercialisation of research and innovation (both technological and non-technological); metrics to know the innovation climate and follow-up on the impact of innovation policies; state legislation on IP both intellectual and industrial compatible with international detection practices and that incentivises inventive activity; state legislation that fosters participation of university staff in activities with the private sector; policies that promote the inculcation of an innovation culture and entrepreneurship as a transversal skill at all education levels; policies to promote industrial growth and competitiveness; affirmative policies for SMEs such as facilities for starting up new businesses, single window for information, initiatives to reduce administrative charges, programmes to detect innovative entrepreneurs, reduced taxes and fiscal incentives for entrepreneurism; mentoring programmes for new business ventures; policies to encourage university staff to create spin-off as well as objectives to increase spin-offs and new innovative start-ups; forums and networking activities; and special initiatives for such target groups such as the youth, women, etc.

Areas of **capacity** include: policies to promote excellence in research and innovation; programmes to facilitate talent hunting and retention in universities; evaluation of universities efforts in knowledge transfer and links with industry; programmes in
training research staff in IPR, commercialisation of knowledge and technology, and knowledge and technology transfer management in universities; programmes that support development of technology transfer (science parks, technology parks, business incubators); policies for training SME entrepreneurs and personnel; programmes to develop entrepreneurial capacities in all the social segments; and results-based economic and academic incentives for university staff in R&D.

Areas under **finance** cover the following: specific budget for STI; tax incentives to promote STI in companies; policies to assist SMEs access credit and subsidies linked to innovation and improving competitiveness; policies to support early-stage innovation projects; budget for programmes in innovation training, training business entrepreneurs; efficient micro-financing programmes; support for networks of business angels/investors; a public risk capital fund; and a secondary stock market.

This section has dealt with the environmental issues surrounding the development of knowledge and technology transfer through innovation. The next turns to institutional and structural aspects of UIGLs.

### 2.5 Institutional Aspects of University-Industry-Government Linkages

This section deals with organisational aspects of university-industry-government linkages, specifically the structure of the linkages, motives for their creation, and challenges that confront their institutionalization.
2.5.1 Structure of University-Industry-Government Linkages

The few available studies on the subject in Kenya focus on university-industry linkages, and indicate some of the mechanisms through which knowledge and technology is moving between universities and industry. A study on the University of Nairobi showed 212 firms with links with the university (Mwamadzingo, 1996:76). These links were at various levels, ranging from the central administration level, faculties, departments, individual lecturers and liaison offices. Projects cited included: Kenya Car Project, UNESCO Pilot Project on Engineering, Foundry Technology Project, *Matricaria Chamomilla* project, among others. The liaison arrangements included: University-Industry Link Committee, Industrial Research and Consultancy Unit, the Housing and Building Research Institute, the Microbiological Resources Centre, and the Clinical and Industrial Biochemistry Consultancy Unit. There are also other arrangements such as Education-Industry Co-operation, University-Industry Co-operative Workshops, dissemination of low-cost building technologies, development of a cultured milk plant, among others. These linkages are summarised under four types: research support linkages, knowledge transfer linkages, technology transfer linkages and general co-operation. However, it is questionable that they qualify as instances of commercialization of knowledge, research or technology (Ng'ethe and Ngome, 2006:13-14).

Another study on the JKUAT cites three broad approaches to linkages with industry as well as specific types. The broad types include: patenting of products and innovations, establishment of JKUATES, and the JKUAT Annual scientific, technological and industrialization conference. There are also specific types of linkages: industrial attachments, development and transfer of appropriate technologies
for MSMEs, joint ventures with industry, establishment of technology and business incubators, and informal individual contacts and consultancies (Ng’ethe and Ngome, 2006:25). Development and transfer of appropriate technology for SMEs has been done through the JKUAT-Kenya Gatsby Trust Project, development of a pulping machine and fresh juice vending trolley, the JKUAT-BIOP neem seed project, application of biotechnology banana farming, and software development for SMEs. Joint ventures with industry include the JKUAT e-Government Academy-Circuits and Packets Communications ICT Training programme, the JKUATES and Collegiate Company’s processing initiative of mango fruits, and the Eco-Housing Technology project.

Odhiambo (2006:9) outlines some of the ways in which Strathmore University promotes and cultivates relationships with industry: appointment of outstanding professionals and industry leaders to the University Council; appointment of CEOs of corporations and other industry leaders to the advisory boards of academic schools and faculties; continuing professional development courses for company executives; interaction through case development by university faculty; joint conferences organized by the university and private firms and corporations; appointment of senior executives from industry as part-time lecturers in the university; industrial internship for students; student projects involving real industry problems; inviting senior executives from industry to participate in curriculum development exercises initiated by the University; sponsorship of students by private firms through scholarships and bursaries; awards and prizes provided by private firms and corporations; alumni networks; consultancy services to the industry by university faculty; training partnerships with various firms, professional associations, among others. To promote
entrepreneurship based on university research, the Strathmore Research and Consultancy Centre was created to manage technology transfer through management of contract research, offering of consultancy services, and commercialisation of knowledge and innovations on behalf of the university.

From the point of view of the creation of a knowledge-based economy, the major linkage mechanisms in the Kenyan context are summarised in Table 2.6:

<table>
<thead>
<tr>
<th>Innovation Activity</th>
<th>Category of Linkages</th>
<th>Modes of Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and</td>
<td>Cooperative research</td>
<td>Joint research</td>
</tr>
<tr>
<td>Experimental</td>
<td>- Training</td>
<td>planning, execution</td>
</tr>
<tr>
<td>Development (Intra-</td>
<td>- Joint cooperation</td>
<td>between scientists on projects of mutual interest</td>
</tr>
<tr>
<td>mural)</td>
<td>- Training</td>
<td></td>
</tr>
<tr>
<td>Research and</td>
<td>Consultancy services</td>
<td>Information transfer</td>
</tr>
<tr>
<td>Experimental</td>
<td>- Procurement of services</td>
<td>Prototype development, analysis</td>
</tr>
<tr>
<td>Development (Extra-</td>
<td>- Training</td>
<td>- Classes, seminars, workshops, fellowships, industrial attachments, specialised training, industrial associates</td>
</tr>
<tr>
<td>mural)</td>
<td></td>
<td>- TTO, ILU</td>
</tr>
<tr>
<td>Activities for</td>
<td>Knowledge and technology transfer</td>
<td>Technology incubator</td>
</tr>
<tr>
<td>Product and</td>
<td></td>
<td>- Science and Technology park</td>
</tr>
<tr>
<td>Process Innovations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Own analysis
It is evident again that most innovation activities within universities are generic and are not contextualized in knowledge and technology transfer to the manufacturing sector.

2.5.2 Motivations for University-Industry-Government Linkages

Barry and Sawyerr (2008:4-8) point out that there must be a basis for interaction around the production and injection of knowledge into industry. Most fundamental is the existence of relevant knowledge, the need for it, and as a disposition for productive engagement. The authors clarify this for both supply and demand dimensions. From a supply perspective, there is the obvious expectation that there are knowledge institutions, but they need to have the capacity to produce useable knowledge, and the orientation and ability to transfer it to industry. This covers the capacity of higher education to produce graduates on the scale and fields relevant to industry and its evolving needs who will staff managerial and technical levels and provide entrepreneurial leadership in the enterprises. It also covers cutting-edge and applications-oriented research that generates useable new knowledge and applications. There is also need for incentives and structures aimed at promoting and facilitating linkages with industry. This entails capacity and disposition of HEIs to transmit such knowledge and technology to the enterprises. From a demand perspective, there is also need for a posture of active receptiveness that translates into effective demand for the knowledge and technology from the HEIs. This takes the form of commitment and investment of time and resources in specific linkage arrangements. These authors also add the need for a supportive public policy framework.
research strengths; and create networking opportunities. Ajayi, Goma and Johnson (1996: 232) sum this up by observing that developing strong and complex links and partnerships with industry is vital for the development of higher education, especially in Africa.

For industries, the motive for interactions would be to solve specific technical problems; the need for general advice over technical programmes and management; desire for access to specific facilities, skills and knowledge provided by faculty consultants; the wish to train or recruit industrial scientific or technical personnel; the need to deepen the firm’s R&D capacity by linking it to an academic base; and the possibility of engaging in joint efforts. Ajayi, Goma and Johnson (1996: 232) add that the shortage of hard currency and spare parts, and international competitiveness are encouraging firms to turn to universities for innovative ideas, improvement of production processes, quality control of goods, and the development of resources appropriate to their needs. Van Zyl, Amadi-Echendu, and Bothma (2007) in a study on the 9 drivers of knowledge transfer between universities and industry in South Africa identify the following reasons: the perception that knowledge is a valuable resource; the need to close the knowledge gap; the emphasis on getting a return on investment in research; the need to extract appropriate knowledge at the right time to make critical decisions; the need to protect knowledge for competitive advantage; the need to protect IP such as trademarks and patents; geographical proximity between the knowledge source and the recipient; and such challenges as natural disasters.

In Kenya, MSEs are faced by constraints that would be of interest for universities to take up, even if the returns to engagement would be insignificant. They include lack of or limited access to appropriate technologies and poor or limited technical and
management skills. The former results from issues related to access to information on available technologies, institutional and professional counselling, appropriate technical skills among entrepreneurs, skills in technology management, product design, refinement and packaging (Laichena and Kobia, 2006). Universities could engage the MSEs through development and transfer of appropriate technology, beefing up communication channels, getting their research, information and training services closer to the entrepreneur and developing and promoting alternative sustainable energy sources.

2.5.3 Challenges to University-Industry-Government Linkages

Mwamadzingo (1996:40) highlights some of the major issues that limit university-industry-government interactions include: differences in missions, objectives, and interests; legal issues regarding IPRs. Ng’ethe and Ngome (2006:36) also agree that universities may have limited view of their wider role, while industry’s pre-occupation with production as a primary mission is also constraining. On the part of universities, the limited funding of research, the poor marketing of university research-based products, and attrition of experienced, qualified staff are key factors. On the part of industry, the predominance of foreign firms in the industrial sector and other sectoral-specific weaknesses are cited as major factors. An example is given of the impact of the collapse of the textile sector due to the decline on cotton farming on the training programmes mounted by some of the universities in Kenya. More enterprise-specific factors are cited in OECD (2005: 112-113) and were outlined in another part of this work. The absence of science and technology parks and weak co-ordination of S&T programmes have implications on government.
2.6 Summary of Literature and Research Gaps

This section has presented a review of relevant literature on the relationship between the interaction of key institutional actors in innovation and the effects in terms of the development of a knowledge-based economy. This review was guided by the research objectives. This section now proceeds to present a summary of what is known and what is not known about each aspect of the themes covered under each objective.

i. Extent to which the entrepreneurial concept exists in universities in Kenya with specific application in the manufacturing sector of the economy.

Literature demonstrates a link between an innovation system, whether national or regional and the development of a KBE in contexts where the science system is well established and where the structures for the commercialization of knowledge and technology are robust. Literature reviewed also demonstrates a relationship between an entrepreneurial university and the development of a knowledge-based economy in contexts where the science system is weak and the role of the government in investing in R&D is prominent since most of GOVERD is channelled into universities. Thus universities in such contexts can play a leading role in generating knowledge and technology that spawns new firms, especially in cutting-edge areas that open frontiers of competitive advantage and international competitiveness. The review revealed a dearth of empirical studies in Kenya on whether an entrepreneurial university-driven NIS involving the knowledge or science base, the manufacturing industry and the policy environment exists. There are no specific studies that conceive of an entrepreneurial university within the context of commercialization platforms and pathways. This constitutes the first gap that underpins this study.
ii. Motivations for the creation of linkages between universities, the manufacturing industry, and the government in the context of knowledge-based industrialization.

Of particular concern is a critical gap in the monitoring of policy interventions with regard to the actual creation of a manufacturing sector that is knowledge-based. In spite of available and growing literature globally on innovation metrics and the types of knowledge sector-productive sector-policy configurations that enhance knowledge-driven and knowledge-based economic growth, there is a dearth of such studies on Kenya. Those available do so from dyadic or bilateral relations between two institutional spheres rather than a triadic approach that includes the role of the policy and structural environment in knowledge transfer and the impact on innovation that underpins the Triple Helix.

iii. Extent to which these linkages can contribute to the attainment of knowledge-based industrialization in Kenya.

As to the question of whether co-evolution of the institutional spheres in an innovation system generated requisite synergies to facilitate the emergence of a KBE and a knowledge-based manufacturing sector, the literature reviewed demonstrated the important role of a co-ordinating mechanism for the efficiency and effectiveness of the innovation system. What this co-ordinating mechanism is differs from country to country. In the Kenyan context, the literature reviewed did not identify what this was.
iv. Methodological gaps

The review was also emphatic about the challenges in the measurement of knowledge, of innovation, and of the knowledge-based economy. Although there are standardized instruments developed to measure each of these aspects, a more eclectic approach that combines more than one approach portended more success than an isolated methodology. As to what this configuration is and whether it would yield fruit in generating answers to the core questions of this study was not precedent in the review. This methodological gap constitutes the final gap that this study sought to fill and is the subject of the next chapter.
CHAPTER THREE
RESEARCH METHODOLOGY

3.0 Introduction

This chapter gives a detailed outline of how the study was executed. It describes the following elements: the research design, location of the study, the target population, the sampling techniques and sample sizes, the research instruments and methods of assuring their validity and reliability, the procedures of data collection and methods of data analysis.

3.1 Research Design

The central purpose of this study was to examine the contribution of universities in Kenya to the country’s knowledge-based industrialization agenda through university-industry-government linkages as platforms for the commercialisation of knowledge and technology in the manufacturing sub-sector of the economy.

The primary goal of social sciences in general is to obtain organised knowledge of social reality. Thus, the research method used depends on the nature of the research problem, the ability of the adopted strategy to address the pertinent questions of the study in a better manner than available alternative methods, and the extent to which there exists knowledge about the subject under investigation (Mwamadzingo, 1996: 48).

The phenomena under investigation in this study had both ‘to what extent’ and ‘how/why’ dimensions. There was need to examine the extent to which UIGLs as platforms for commercialization of knowledge and technology exist, which constitutes the quantitative dimension of the study phenomenon. Further, it was
necessary to establish the motives for their establishment and their impact with regard to the emergence of the knowledge-based manufacturing sector, an aspect that required a close-up observation of their manifestation in limited cases and a triangulation of evidence from multiple sources other than the quantitative results. This close-up involved obtaining views of stakeholders intimately involved in innovation from national policy organs as well as institutional actors as well as detailed examination of documents.

As Creswell and Plano Clark (2007: 26) observe, such an approach is underpinned by the pragmatic world view that ‘embraces what works, using diverse approaches, and valuing both objective and subjective knowledge’. Thus, the dichotomy between post-positivism underlying quantitative research and constructivism underpinning qualitative research is de-emphasized, and thus both quantitative and qualitative research methods can be used in the same study. Further, the problem under investigation in this study could not be adequately explored through one approach only. The combination of quantitative and qualitative data ‘provides a more complete picture by noting trends and generalizations as well as in-depth knowledge of participants’ perspectives’ (Creswell and Plano Clark, 2007:33).

This study therefore adopted the QUAN-qual explanatory approach in the mixed methods research design in which the researcher collected quantitative data from a survey of public and private universities in Kenya using a standardised questionnaire and then collected interview-based qualitative data through in-depth case studies of selected linkage platforms and content analyses of selected government policy documents (Gay, Mills and Airasian 2009: 463; Creswell and Clark, 2007:10-11). The
questions posed in this study required a determination and reporting of the status of commercialisation of knowledge and technology in manufacturing through UIGLs linkages as a means of creating a knowledge-based industrial sector as envisioned in the Kenya Vision 2030 (Gay, Mills and Airasian: 9). However it was not enough to establish the status without interrogating structural and policy issues that are raised around these interactions, thus the rationale for the follow-up study with the relevant policy-making organs. Figure 3.1 summarizes the research design approach as adopted by the study:
PHASE ONE

QUAN data Collection
  UIGLS Survey
    Frequency counts

Quan data analysis
  Descriptive Statistics
    Frequencies and percentages

QUAN results
  Discussions
    Description of results

Pose new questions to explain QUAN findings

Identify outcomes relevant for in-depth interrogation

1. Specify case question
2. Select follow-up cases

Qual data analysis

1. Policy matters interviews
2. Industry interviews
3. Entrepreneur interview
4. Content analysis of policy documents

1. Case description
2. Material from policy documents

PHASE TWO

Qual data analysis

1. Cross-case analysis
2. Quantitative analysis

1. Cross-case analysis
2. Quantitative analysis

Overall findings and interpretation

Explain QUAN statistics with qualitative findings

Figure 3.1: Explanatory QUAN-qual Mixed Methods Research Design (Adapted from Creswell and Plano Clark, 2007:73)
3.2 Location of the Study

The appropriateness of Kenya as a developing country for this study as a developing country is enhanced due to its current recognition of the role that an innovation system can play in accelerating development through its current development blueprint, the Kenya Vision 2030. However, the extent of that recognition in terms of policy implementation has not yet been systematically analysed. Further, unlike Mwamadzingo's study that is a case study of U-I links at the University of Nairobi without explicit inclusion of the government as an explicit component, this was a broader study of UIGLs in both public and private universities in Kenya.

3.3 Target Population

The study targeted senior university managers in all public and private 49 universities in Kenya; 5 policy-makers in the Ministries of Planning, National Development and Vision 2030; Industrialisation; and Higher Education, Science and Technology; and 2 key informants from the manufacturing industry as representatives of the two manufacturers associations in Kenya, Kenya Manufacturer Association (KAM) and Kenya Private Sector Alliance (KEPSA). According to the Commission for University (CUE, 2013), in 2013 there were 49 universities in Kenya. These are presented by ownership below.

i. Public Universities

The following universities had individual Acts which were repealed following the enactment of the Universities Act No.42 of 2012: University of Nairobi, Moi University, Kenyatta University, Egerton University, Jomo Kenyatta University of
Agriculture and Technology, Maseno University and Masinde Muliro University of Science and Technology.

The next set of universities were constituent colleges established by legal orders and operated under their respective parent university acts, but which were subsequently awarded a Charter: Dedan Kimathi University of Technology, Chuka University, Technical University of Kenya, Technical University of Mombasa, Pwani University, Kisii University, University of Eldoret, Maasai Mara University, Jaramogi Oginga Odinga University of Science and Technology, Laikipia University, Southern Eastern Kenya University, Meru University of Science and Technology, Multimedia University of Kenya, University of Kabianga, and Karatina University. Thus the total number of public universities stood at 22.

ii. Private Universities

The following private universities have been fully accredited and awarded charters: University of Eastern Africa-Baraton, Catholic University of Eastern Africa, Scott Theological College, Daystar University, United States International University, Africa Nazarene University, Kenya Methodist University, St. Paul’s United Theological University, Pan Africa Christian University, Strathmore University, Kabarak University, Mount Kenya University, Africa International University, and Kenya Highlands Evangelical University.

Those with Letters of Interim Authority include: Kiriri Women’s University of Science and Technology, Aga Khan University, Presbyterian University of East
Africa, Gretsa University, Adventist University of Africa, Innorero University, The East Africa University, Genco University and Management University of Africa. Registered private universities include: Nairobi International School of Theology and the East Africa School of Theology.

3.4 Sampling Techniques and Sample Size

3.4.1 Universities

The researcher sampled 17 universities for the study. All the 7 universities established before the current Universities Act (see Part X, Section 71.1a-h: 1905-1906) were included in the survey since it was necessary to find out if they had a commercialization base on the basis of their length of existence. The researcher also purposively selected 3 of the newer public universities with the phrase ‘Science and Technology’ in their name. The rest of the 4 were randomly sampled from the remainder in the list of public universities. Finally 3 well-established private ones were purposively sampled to find out if they had a commercialisation base.

3.4.2 Policymakers

It was considered necessary to get the insights of senior government technocrats in development planning, economic and STI subsectors so as to shed more light on issues that were to be generated from the UIG survey. Therefore, the study also targeted the following policy makers relevant in the national development, economic and STI sectors: the Chief Economist in the Ministry of Devolution and National Development, the Assistant Director of the Economic Pillar, Kenya Vision 2030 in the same ministry, the Chief Economist in the Ministry of Industrialisation and Enterprise Development, the Director of Higher Education (DHE), the Secretary of
NACOSTI, and the Director of Research Management and Development, and the Secretary of the Commission for University Education.

3.4.3 **Manufacturing Associations Representatives**

The researcher also conducted interviews with the Chief Executive Officer of the Kenya Association of Manufacturers, the Chief Executive Officer of Kenya Private Sector Alliance (KEPSA).

Table 3.1 presents the sample size:

**Table 3.1: Study Population**

<table>
<thead>
<tr>
<th>Category</th>
<th>Study Population</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior University managers</td>
<td>49</td>
<td>17</td>
</tr>
<tr>
<td>Director, Economic Pillar KV2030</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chief Economist, Ministry of Industrialisation and Enterprise Development</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ministry of Education, Science and Technology:</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Secretary, NACOSTI; Director, DRMD</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Secretary, Commission for University Education</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Manufacturing sector</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>56</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

3.5 **Research Instruments**

The researcher used three questionnaires, three interview schedules and a content analysis proforma to collect data. These are:

a. **The Universities-Manufacturing Industry-Government Linkages (UIGLs)**

   **Baseline Survey Questionnaire:** This instrument captured the following data:
institutional background; institutional arrangements, interface structures and policies on linkages and related matters; types of engagements with the productive sector and related matters; and strengths, challenges and needs. There were both open and close-ended questions. This instrument targeted a high ranking officer in each of the universities’ administration hierarchy.

b. **Innovating Manufacturing Enterprise Questionnaire:** This instrument targeted manufacturing enterprises hoisted on a UIGL platform in which successful commercialization of knowledge and technology had occurred. The purpose was to find out innovations characteristics of successful ventures. The standard instrument used for this is the Frascati Manual’s Community Innovation Survey, CIS.

c. **Policy-makers Interview Schedules:** The next set of instruments targeted policymakers in the Ministries of Devolution and Planning, in the Kenya Vision 2030 Vision Delivery Board; Industrialisation and Enterprise Development ; and Education, Science and Technology. These were targeted due to the need to find out their stand on university-manufacturing industry linkages but especially to clarify any details that arise from the first phase of the study with the universities and innovating manufacturing firms. The researcher interviewed the Chief Economist at the Ministry of Devolution and Planning, National Development and Vision 2030, the director of the Kenya Vision 2030 in the same Ministry; the Chief Economist at the Ministry of Industrialisation; and the Director of University Education, the Secretary of the National Council of Science and Technology, and the Director, Directorate of Research Management and Development all at the Ministry of Education, Science and Technology.
d. **Manufacturing Associations Informants Interview Schedules:** These interview schedules sought information from the representatives of manufacturing enterprises. Specific information sought was their understanding of a knowledge-based manufacturing sector and their opinions on what they felt was the role of universities in facilitating the development of knowledge-based industrialization in Kenya.

e. **Policy Documents Content Analysis Proforma:** The final instrument was a content analysis of key government policy documents in relation to the recognition of the role of university-industry-government linkages in facilitating the country’s industrialisation agenda. These documents consisted of all the policy documents within the First Medium Term Plan, 2008-2012. This analysis aimed at examining the extent of co-evolution in the three institutional spheres in the creation of a knowledge-based economy for Kenya.

### 3.6 Validity

The researcher used expert judgement to assure the content validity of the instruments. The experts helped to determine the domain of the specific content that the instruments outlined in the previous section were assumed to represent, to determine how well the content universe had been sampled by the instruments’ items, and to determine their relevance and completeness. These experts were drawn from the fields of academic research, economics of education and planning/policy studies, and development studies.

### 3.7 Reliability

The reliability of the AAU-AUCC questionnaire was tested after the pilot study. The researcher used intra-institutional simultaneously administered test technique to test
the consistency of responses to the AAU-AUCC UIGLs questionnaire through having two sets of respondents in the same institution, one from academic administration and the other from the research division respond to it. The reliability coefficient computed using the Pearson’s Product Moment Correlation Coefficient was 0.825, which was judged to represent a high level of consistency between the two sets of responses (Gay, Mills and Airasian, 2009:161).

3.7.1 Pilot Study
Piloting was done in two universities, one public and another private. A pilot report was generated and was used to improve on the research instruments. For example, in the AAU-AUCC UIGLs questionnaire, items that referred to language spoken was deleted since English is the official language in Kenya. In the CIS questionnaire, the sections on Organisational and Marketing Innovation were also deleted since the focus was on Product and Process Innovation.

3.8 Data Collection Procedures
The researcher first applied for a research permit from the NACOSTI. The data collection exercise then followed the stages outlined below:

a. Recruitment and training of research assistants for the UIGL survey;

b. Administration of questionnaires in respondent universities, especially through the research assistants filling the instrument with the respondents to enhance satisfactory completion;

c. Administration of interviews;

d. Assembling of the research instruments and debriefing of the research assistants.

e. Review of relevant policy documents emerging from the interviews of key informants.
3.9 Method of Data Analysis

Data was collected in three key ways: a survey of 17 universities, case studies of two universities through interview schedules and observation, and document analysis of key STI and national development policy documents. From the survey, 17 questionnaires were returned, representing a response rate of 100%. The researcher assembled all the returned instruments for cleaning, editing and coding. The data was keyed in on an SPSS spreadsheet, and then version 2.0 of the SPSS package was used to generate summary descriptive statistics in the form of frequencies. Descriptive graphics were used to present the summarised trends in the data. From the case studies of the 2 universities with UIGLs linkages in manufacturing, cross-case analysis following the major themes was conducted. Finally, content analysis of the policy documents related to Kenya Vision 2030 from the three ministries was conducted to identify key themes in national development, STI and industrialization policy and these were used to triangulate similar themes from the cross-case analysis. The findings were presented in a table that attempted to portray institutional co-evolution in the emergence of a knowledge-based manufacturing sector.

3.10 Ethical Considerations

All participants at all stages of the study were treated with dignity, respect, and their privacy highly respected. All the sources of information and research whose findings and sentiments shaped this study in one way or the other were duly acknowledged through proper referencing and citations to cater for academic plagiarism.

To ensure privacy and confidentiality of all the participants involved in this study, the participants were requested not to write their names or describe themselves in any manner that would reveal their identity or that of their institutions during the process.
of conducting the study. For the case universities whose details were revealed in the study, express authority was sought and the approval letters are appended to this document.

The researcher ensured that the respondents participated in the study willingly. The respondents therefore signed Consent to Participate Form. The researcher ensured that all appropriate chains of command as outlined in the NACOSTI Research Permit were followed while in the field.
CHAPTER FOUR
DATA PRESENTATION, ANALYSIS, AND DISCUSSIONS

4.0 Introduction

This chapter presents the data obtained from the field study, analysis and discussions within the framework of the study’s central purpose, objectives and hypothesis. To put this in perspective, the central purpose was to examine the contribution of universities in Kenya to the country’s industrialization agenda through university-industry-government linkages in the manufacturing sub-sector of the economy. The objectives that guided the research study are presented below: to

i. Examine the extent to which the entrepreneurial concept exists in universities in Kenya with specific application in the manufacturing sector of the economy;

ii. Analyse the motivations for the creation of linkages between universities, the manufacturing industry, and the government in the context of knowledge-based industrialization;

iii. Examine the extent to which these linkages can contribute to the attainment of knowledge-based industrialization in Kenya;

iv. Identify the challenges facing the development of these linkages;

v. Suggest interventions to be instituted to enhance the potential of the linkages to promote the development of knowledge-based industrialization in Kenya.

4.1 Demographic Characteristics of Universities

The first part of this chapter sought to present the salient demographic characteristics of the 17 participating universities. This description included a description of the following variables: ownership, location, primary strategic focus, postgraduate programmes, enrolment and academic staff capacity. These variables are deemed to
have an influence on the extent and type of platforms that can facilitate the
commercialization of knowledge and hence on the creation of a knowledge-based
manufacturing sector in Kenya.

4.2.1 Type of University

Whether a participating university was considered to be public or private (whether
profit or non-profit) was considered an important variable with regard to the capacity
to conduct research and to develop linkages to commercialise knowledge. The
ownership profile is presented in Figure 4.1:

![Pie chart showing percentages of private and public universities.]

**Figure 4.1: Type of University**

There were 14 (82%) public universities and 3 (18%) private ones (2 not-for-profit and
1 for-profit).
4.2.2 Location of University

The location of the university was an important factor in the relation to its prospective influence on its surroundings. This is especially so bearing in mind the tendency of manufacturing industries to be situated near urban areas, and of the capacity of entrepreneurial universities to encourage the spawning of new industries. Figure 4.2 presents the findings on the location of the respondent universities:

![Figure 4.2: Location of University](image)

The findings indicate that 8(47%) of the respondent universities were located in an urban area, 5(29%) in a peri-urban area and 4(24%) were in rural locations.

4.2.3 Primary Strategic Focus of the University

A consideration of the primary strategic focus of a university was central in helping determine its capacity to mount a variety of programmes and to possess requisite staff
that can interest those who would be interested in initiating linkages with the university. Figure 4.3 presents the summary:

![Bar chart showing primary strategic focus of the university.]

**Figure 4.3: Primary strategic focus of the university**

The results indicate that 10 (56%) of the 17 participating universities have a comprehensive range of faculties and degree programmes, 4 (23%) have a focus on Science and Technology, 1 (6%) on Agriculture and Technology, 1 (6%) on Business, and 1 (6%) on Arts, Social Sciences and Humanities.

### 4.2.4 Postgraduate Degrees

The ability to conduct research and generate new knowledge depends on a university's capacity to mount postgraduate programmes. All participating universities offered postgraduate degrees.
4.2.5 Student Enrolment and Academic Staff Establishment

Enrolments of students has been one of the key criteria of determining staffing, both academic and support staff. Figure 4.4 and Table 4.1 show the enrolment levels of students, the academic staffing levels, and the academic staff-student ratios in the respondent public universities. Unfortunately, data from private universities was unavailable. Figure 4.4 presents the enrolments in the respondent universities:

![Graph showing student enrolment percentages]

Figure 4.4: Enrolment of students, 2013

Source: Commission for University Education, 2013

The figure indicates that a quarter of the respondent universities have 5,000 students or less, another quarter with between 5,001 and 10,000, another quarter between 10,000 and 25,000 and finally another quarter with more than 25,000. These figures corroborate enrolment statistics for public universities available at the Commission for University Education (CUE) shown in Table 4.1:
<table>
<thead>
<tr>
<th>UNIVERSITY</th>
<th>MALE</th>
<th>FEMALE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.o.N</td>
<td>35,540</td>
<td>20,624</td>
<td>56,164</td>
</tr>
<tr>
<td>Moi</td>
<td>21,020</td>
<td>18,125</td>
<td>39,145</td>
</tr>
<tr>
<td>K.U.</td>
<td>33,612</td>
<td>27,148</td>
<td>60,760</td>
</tr>
<tr>
<td>Egerton</td>
<td>11,719</td>
<td>7,175</td>
<td>18,894</td>
</tr>
<tr>
<td>JKUAT</td>
<td>15,806</td>
<td>7,981</td>
<td>23,787</td>
</tr>
<tr>
<td>Maseno</td>
<td>6,213</td>
<td>3,522</td>
<td>9,735</td>
</tr>
<tr>
<td>MMUST</td>
<td>6,638</td>
<td>3,687</td>
<td>10,325</td>
</tr>
<tr>
<td>Dedan Kimathi</td>
<td>4,159</td>
<td>1,530</td>
<td>5,689</td>
</tr>
<tr>
<td>Chuka</td>
<td>5,130</td>
<td>3,020</td>
<td>8,150</td>
</tr>
<tr>
<td>TUK</td>
<td>3,010</td>
<td>1,902</td>
<td>4,912</td>
</tr>
<tr>
<td>TUM</td>
<td>1,916</td>
<td>475</td>
<td>2,463</td>
</tr>
<tr>
<td>Pwani</td>
<td>2,356</td>
<td>1,479</td>
<td>3,835</td>
</tr>
<tr>
<td>Kisii</td>
<td>5,809</td>
<td>3,588</td>
<td>9,397</td>
</tr>
<tr>
<td>Eldoret</td>
<td>5,037</td>
<td>2,966</td>
<td>8,003</td>
</tr>
<tr>
<td>Maasai Mara</td>
<td>1,472</td>
<td>772</td>
<td>2,244</td>
</tr>
<tr>
<td>JOOUST</td>
<td>1,867</td>
<td>1,391</td>
<td>3,258</td>
</tr>
<tr>
<td>Laikipia</td>
<td>2,392</td>
<td>2,466</td>
<td>4,858</td>
</tr>
<tr>
<td>SEKU</td>
<td>1,162</td>
<td>609</td>
<td>1,771</td>
</tr>
<tr>
<td>Meru</td>
<td>1,826</td>
<td>912</td>
<td>2,738</td>
</tr>
<tr>
<td>Multimedia</td>
<td>2,410</td>
<td>1,666</td>
<td>4,076</td>
</tr>
<tr>
<td>Kabianga</td>
<td>2,273</td>
<td>1,570</td>
<td>3,843</td>
</tr>
<tr>
<td>Karatina</td>
<td>1,820</td>
<td>1,356</td>
<td>3,176</td>
</tr>
</tbody>
</table>

Figure 4.5 shows the academic staffing levels in the respondent universities.

![Diagram showing academic staffing levels, 2013](image)

Figure 4.5: Academic staffing levels, 2013

The validity of these figures was strengthened when they were corroborated by the official statistics from the CUE presented in Table 4.2:
### Table 4.2: Academic Staff, Public Universities in Kenya, 2013

<table>
<thead>
<tr>
<th>UNIVERSITY</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.o.N</td>
<td>1610</td>
</tr>
<tr>
<td>Moi</td>
<td>754</td>
</tr>
<tr>
<td>K.U.</td>
<td>961</td>
</tr>
<tr>
<td>Egerton</td>
<td>509</td>
</tr>
<tr>
<td>JCUAT</td>
<td>2172</td>
</tr>
<tr>
<td>Maseno</td>
<td>368</td>
</tr>
<tr>
<td>MMUST</td>
<td>318</td>
</tr>
<tr>
<td>Dedan Kimathi</td>
<td>124</td>
</tr>
<tr>
<td>Chuka</td>
<td>163</td>
</tr>
<tr>
<td>TUK</td>
<td>284</td>
</tr>
<tr>
<td>TUM</td>
<td>210</td>
</tr>
<tr>
<td>Pwani</td>
<td>122</td>
</tr>
<tr>
<td>Kisii</td>
<td>138</td>
</tr>
<tr>
<td>Eldoret</td>
<td>252</td>
</tr>
<tr>
<td>Maasai Mara</td>
<td>83</td>
</tr>
<tr>
<td>JOOUST</td>
<td>97</td>
</tr>
<tr>
<td>Laikipia</td>
<td>79</td>
</tr>
<tr>
<td>SEKU</td>
<td>105</td>
</tr>
<tr>
<td>Meru</td>
<td>66</td>
</tr>
<tr>
<td>Multimedia</td>
<td>121</td>
</tr>
<tr>
<td>Kabianga</td>
<td>225</td>
</tr>
<tr>
<td>Karatina</td>
<td>75</td>
</tr>
</tbody>
</table>

Finally, Table 4.3 shows the academic staff-student ratios for public universities:

Table 4.3: Academic Staff/Student Ratios (SSR), Public Universities in Kenya, 2013

<table>
<thead>
<tr>
<th>UNIVERSITY</th>
<th>STUDENTS</th>
<th>STAFF</th>
<th>RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.o.N</td>
<td>56,164</td>
<td>1610</td>
<td>35</td>
</tr>
<tr>
<td>Moi</td>
<td>39,145</td>
<td>754</td>
<td>52</td>
</tr>
<tr>
<td>K.U.</td>
<td>60,760</td>
<td>961</td>
<td>63</td>
</tr>
<tr>
<td>Egerton</td>
<td>18,894</td>
<td>509</td>
<td>37</td>
</tr>
<tr>
<td>JKVAT</td>
<td>23,787</td>
<td>2172</td>
<td>11</td>
</tr>
<tr>
<td>Maseno</td>
<td>9,735</td>
<td>368</td>
<td>26</td>
</tr>
<tr>
<td>MMUST</td>
<td>10,325</td>
<td>318</td>
<td>32</td>
</tr>
<tr>
<td>Dedan Kimathi</td>
<td>5,689</td>
<td>124</td>
<td>46</td>
</tr>
<tr>
<td>Chuka</td>
<td>8,150</td>
<td>163</td>
<td>52</td>
</tr>
<tr>
<td>TUK</td>
<td>4,912</td>
<td>284</td>
<td>17</td>
</tr>
<tr>
<td>TUM</td>
<td>2,463</td>
<td>210</td>
<td>12</td>
</tr>
<tr>
<td>Pwani</td>
<td>3,835</td>
<td>122</td>
<td>31</td>
</tr>
<tr>
<td>Kisii</td>
<td>9,397</td>
<td>138</td>
<td>68</td>
</tr>
<tr>
<td>Eldoret</td>
<td>8,003</td>
<td>252</td>
<td>32</td>
</tr>
<tr>
<td>Maasai Mara</td>
<td>2,244</td>
<td>83</td>
<td>27</td>
</tr>
<tr>
<td>JOOUST</td>
<td>3,258</td>
<td>97</td>
<td>34</td>
</tr>
<tr>
<td>Laikipia</td>
<td>4,858</td>
<td>79</td>
<td>61</td>
</tr>
<tr>
<td>SEKU</td>
<td>1,771</td>
<td>105</td>
<td>17</td>
</tr>
<tr>
<td>Meru</td>
<td>2,738</td>
<td>66</td>
<td>41</td>
</tr>
<tr>
<td>Multimedia</td>
<td>4,076</td>
<td>121</td>
<td>34</td>
</tr>
<tr>
<td>Kabianga</td>
<td>3,843</td>
<td>225</td>
<td>17</td>
</tr>
<tr>
<td>Karatina</td>
<td>3,176</td>
<td>75</td>
<td>42</td>
</tr>
</tbody>
</table>
The Figure illustrates the very high academic staff-student ratios that have accompanied the high enrolments in public universities. Okewo (The Daily Nation, Monday June 2 2014) reports that most universities are grappling with shortage of professors and doctorate degree holders who comprise a key component in spearheading research and supervising postgraduate students. A British Council commissioned study citing a CUE commissioned report echoes these findings by noting that at the major public universities there are now as many as 64 students for every member of academic staff, way above global benchmarks (RoK, 2006:88-91; British Council, 2014:3, 6).

4.2.6 Academic Qualifications of Academic Staff

The proportion of doctoral degree holders among academic staff at respondent institutions is important for initiating, undertaking research, supervision of graduate students and for facilitating sustainable linkages with the productive sector. Figure 4.7 presents the institutional profile information on this critical variable:

![Figure 4.6: Academic staff with doctorate degrees, 2013](image-url)
Less than a quarter of the academic staff in the majority of the respondent universities have doctoral degrees. This trend exists in both the public and private universities, worse especially in the newer public universities and the private ones (CUE, 2013). Again, this has implications for the ability to conduct research and for the capacity to build linkages with the productive sector especially to promote knowledge and technology transfer (Okewo, 2014; Cloete and Bunting, 2013:43-4; Barry and Sawyerr, 2008: 12) constituting the first major structural weakness of the university as a part of the science system in Kenya.

4.3 Extent to which the Entrepreneurial University Exists in Kenya
The first research objective of the study was to find out the extent to which universities in Kenya provided the knowledge base for manufacturing in Kenya through UIG linkages as platforms for commercialisation of knowledge and technology. In order to do so, the following research questions were posed:

1. What institutional arrangements and interface structures exist for the commercialization of knowledge in the universities in Kenya?
2. What is the level and type of engagement with the productive sector in general and with manufacturing in particular?

4.3.1 Institutional Arrangements and Interface Structures
The key issue addressed in this section is whether there is a structural basis for an entrepreneurial university that can initiate and sustain linkages with the productive sector in general and manufacturing in particular, especially in light of the findings in the demographic section of this chapter. These structures include emphasis in institutional strategic plans, specific positions that champion linkages, policies on
UIG linkages and relations with a national innovation system. These aspects are explored in the sections that follow.

4.3.2 University Strategic Plan and Linkages with the Productive Sector

The university system in Kenya has adopted strategic planning as a key tool for institutional development. This is in line with changing global trends where organisations have increasingly adopted performance-based systems, and strategic planning is one of the pillars of such a system. In fact, all the respondent universities had a strategic plan available in their respective websites. As such, it was important to establish whether there was specific mention of building linkages with the productive sector in the SPs. Figure 4.7 presents the findings:

Figure 4.7: Reference to building linkages in strategic plan
As the diagram above indicates, the majority of the respondent universities’ strategic plans did refer to building linkages with the productive sector. Samples of these references in the SPs are quoted below:

*Potential for University-Industry Links and Consultancies (Kenyatta University, p.13) as an opportunity in SWOT analysis; Develop collaboration with Ministries, Industries and CBOs (Kenyatta University p.33).*

In the JKUAT’s SP the areas where linkages are mentioned include:

*Attention shall be paid to issues of relevance and responsiveness to the market and to national policies. In practice, university education should be demand-driven, of high quality, gender sensitive, technologically informed, research supported, well-governed and globally marketable. All these will heavily gain through creation of linkages with universities and relevant industries.* (PESTEL-Political factors, JKUAT Strategic Plan 2004-2014, p.13)

Linkages and partnerships constitute a section under situational analysis (JKUAT SP, 2004-2014). Further, there are sections on Research and Innovation and on Community Extension and Technology Transfer in the Plan.

Ssebuwufu, Ludwick and Beland (2011:22) observe that strategic plans can provide vision for shaping and directing research priorities, can help build research capacity in an institution by prioritising research projects that align with university objectives, and can involve a wide section of an institution’s research community. ACUP-CIGU (2013:50-52) observe that an institutional strategy that determines priority areas of RDI is part of creating a favourable environment for UIGLs. Grobler and van Niekerk (cited in Howlett 2010:132) include inclusion of commercialisation aspects in the university’s strategic plan as one of the critical success factors for an entrepreneurial university.
4.3.3 University Positions Promoting Linkages with the Productive Sector

As a follow-up to the emphasis given to linkages with the productive sector in institutional SPs by the respondent universities, it was therefore necessary to find out if there were specific structures instituted by these universities to facilitate the creation and implementation of the linkages. These structures could include specified positions to promote linkages and dedicated offices. The findings on designated positions are outlined in Figure 4.8:

![Figure 4.8: Positions promoting linkages](image)

From the figure above, it is evident that a majority of respondent institutions have designated positions to encourage linkages with the productive sector. In the Deputy VC/Pro-VC/Vice-Rector/Vice-President category, 76.5% of the respondent universities reported that they had such a position. In the Provost/Dean/Director/Principal category, 56.3% of the universities had such a
position. In the Industrial Liaison category, 47.1% of the respondent universities had such a position. Few universities (25.8%) had a Committee on Industrial Cooperation. Quite a number of the respondent universities had representation from the productive sector in the governing council/board. This is one of the areas in which The Universities Act 2012 (Clause 3.2e:1861) envisages as important, the ‘promotion of public-private partnership in university education and development’. Finally, 46.7% of respondent universities had other individuals responsible for the promotion of linkages with the productive sector such as ‘Co-ordinator’. It is worthwhile noting at this point that the two respondents in a subsequent interview in two of the selected case universities with linkages with the manufacturing sector were co-ordinators of an Industrial Liaison Unit and a University Incubator.

4.3.4 Dedicated Unit Facilitating and Promoting Linkages with the Productive Sector

Another part of a university’s commitment to facilitating and instituting UIGLs is the creation of a dedicated office/unit to handle these linkages. Such an office could take the form of an Intellectual Property Office, an Industrial Liaison Unit, or a Directorate of Consultancies. Respondents were asked to indicate whether their institutions had or did not have such an office/unit. Figure 4.9 presents their responses:
A majority of the respondent universities (13 or 76\%) had a dedicated unit of office to promote and facilitate linkages with the productive sector. This is a positive indication of efforts to foster and institutionalize linkages with the productive sector, a trend also acknowledged by Ssebuwufu, Ludwick and Beland (2011: 20-1).

Further to the issue of the existence of the dedicated unit/office, it was necessary to find out the priority given to such a structure with regard to its location. Respondents were asked to state where the unit/office was located. The responses are presented in Figure 4.10:
Figure 4.10: Location of dedicated unit

From the Figure above, it can be observed that the majority of dedicated units/offices, 5 (43 %) are housed in the office of the DVC/Vice-Rector, which would be recognised as a division within senior university management. For 3(18 %) respondents who indicated that the location was another office located in central administration, they were required to specify the location. Only 1(6 %) respondent gave a specific response, indicating that the unit was part of the R&E division. It can be concluded, then, that the dedicated office was accorded priority in respondent universities.

What were main responsibilities of this office? This question was considered very critical because it lies at the heart of commercialization of knowledge and technology. The activities that the unit is engaged in significantly define whether a university is becoming entrepreneurial or not. Respondents were required to choose from 11 options. Their responses are presented in Table 4.4:
Table 4.4: Main responsibilities of dedicated unit

<table>
<thead>
<tr>
<th></th>
<th>YES %</th>
<th>NO %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patenting and licensing</td>
<td>29.4%</td>
<td>70.6%</td>
</tr>
<tr>
<td>Contract negotiation</td>
<td>52.9%</td>
<td>47.1%</td>
</tr>
<tr>
<td>Seeking and managing venture capital</td>
<td>23.5%</td>
<td>76.5%</td>
</tr>
<tr>
<td>Development and management of spin-off companies</td>
<td>11.8%</td>
<td>88.2%</td>
</tr>
<tr>
<td>Networking and seeking out external partners</td>
<td>70.6%</td>
<td>29.4%</td>
</tr>
<tr>
<td>Managing technology incubators</td>
<td>41.2%</td>
<td>58.8%</td>
</tr>
<tr>
<td>Managing science parks</td>
<td>23.5%</td>
<td>76.5%</td>
</tr>
<tr>
<td>Managing cooperatives with local business entrepreneurs</td>
<td>23.5%</td>
<td>76.5%</td>
</tr>
</tbody>
</table>

From the diagram and Figure, ‘networking and seeking out external partners’ (70.6 %), and ‘contract negotiation’ are the key duties of the dedicated unit/office. It is disquieting to note that those aspects that are very instrumental for commercialization of knowledge do not feature prominently in the responsibilities list, such as ‘patenting and licensing’ (29.4 %), ‘seeking and managing venture capital’ (23.5 %), ‘development and management of spin-off companies’ (11.8 %), ‘managing technology incubators’ (41.2 %) and ‘managing science parks’ (23.5 %). This supports findings elsewhere in Africa that not only is the number of institutions with this knowledge commercialization infrastructure actually very small but also that other activities in these units are housed there (AAU-AUCC, 2013:37-43). Ssebuwufu, Ludwick and Beland (2011) attribute this state of affairs to among others, such factors as limited budgets, low percentage of academic staff with requisite experience and qualifications, lack of access to research laboratories and up-to-date equipment, and
limited expertise in IP management. Other responsibilities of the unit/office that were reported included: seeking motivational awards from industry for students as well as conducting a special attachment referred to as Students Work Induction Programme (SWIP) which is more comprehensive than ordinary work internships/attachments; waiting for other individual to bring projects; and educational support in curriculum development.

In order to carry out the duties reported above, it was considered useful to find out what type of expertise was recruited. Respondents were asked to indicate the types of specialists employed by the unit from a provided set. Their responses are presented in Table 4.5:

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract/intellectual property (IP)</td>
<td>23.5%</td>
<td>76.5%</td>
</tr>
<tr>
<td>Entrepreneurial expert</td>
<td>17.6%</td>
<td>82.4%</td>
</tr>
<tr>
<td>Marketing specialist</td>
<td>35.3%</td>
<td>64.7%</td>
</tr>
<tr>
<td>Industrial relations expert</td>
<td>41.2%</td>
<td>58.8%</td>
</tr>
</tbody>
</table>

From the Table above, it is evident that an Industrial Relations expert is the most common specialist (41.25 %), followed by a Marketing specialist (35.3 %), then an IP/Contract expert. This finding is consistent with the finding above that ‘Networking and Seeking Out External Partners’ was the main duty of the dedicated office. This would require Industrial Relations/Marketing expertise. A Contract/IP expert handles IP Contract/IP issues such as contract negotiation, and patenting and licensing. Other
types of specialists cited include Lobbyist and Negotiating Expert (1), academic staff (3), and a Communications expert (1). This finding is consistent with the continuum in institutionalization of entrepreneurialism in a university whereby the initial focus will be to seek out potential partners, to market the commercial potential of the university, then deal with IP/Contract matters once there are fruitful initiatives (Etzkowitz, 2004:67).

In light of the findings above, the next question that arose was whether the dedicated units/offices were satisfied with the status quo with regard to the levels and number of expertise available or whether they would require additional specialists. The responses are presented below:

![Figure 4.11: Additional expertise needed in dedicated unit](image-url)
From the Figure above, among the 7 respondent universities, 2 (29 %) felt they would require the combination of Entrepreneurial/Marketing/Industrial relations expertise, 2 (29 %) felt they needed just a Contract/IP expert, 1 (14 %) felt they needed an Entrepreneurial/Marketing expertise, 1 (14 %) Industrial Relations/Marketing expertise, and 1 (14 %) Technical and Engineering expertise. The interesting observation is that once more only 2 respondent universities felt they would need an IP expert, though there were more responses in favour of an Entrepreneurial expert. Again, this is consistent with the needs of an emerging entrepreneurial outlook in a university as predicted in the model by Etzkowitz (2004:67).

Another important aspect of the priority given to UIG linkages was considered to be the financial allocation to facilitate its activities. This would enable the various activities reported as the functions of the unit/office to be implemented. The respondents were required to indicate the range within which the annual budget lay from ‘Less than $5,000 (approximately K.shs. 4 million), ‘$ 5,001-$ 10,000’ (approximately K.shs.4 and 8 million), ‘$ 10,000-$ 25,000 (approximately K.shs. 8 and 20 million), $ 25,001-$ 50,000 (approximately K.shs. 20 and 40 million), and more than $50,000 (i.e. more than K.shs. 40 million. The findings are captured in the Figure below:
Figure 4.12: Annual budget of dedicated unit (US $)

This data is not very useful if it is not compared to the level of activity for which the budget was pegged. Thus, the various budget items indicated by each respondent university were compared to the range of activities that the respondents indicated the dedicated unit/office performed. Table 4.6 attempts to show this for the 10 respondent universities who provided responses on this item:
Table 4.6: Comparison of dedicated unit activities and budget

<table>
<thead>
<tr>
<th>University</th>
<th>Budget ($)</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egerton</td>
<td>&lt; 5,000</td>
<td>√</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Embu</td>
<td>&lt; 5,000</td>
<td>x</td>
<td>√</td>
<td>√</td>
<td>x</td>
<td>√</td>
<td>√</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>JKUAT</td>
<td>&lt; 5,000</td>
<td>√</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>JOOUST</td>
<td>10,000-25,000</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Kenyatta</td>
<td>25,000-50,000</td>
<td>√</td>
<td>x</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Maasai</td>
<td>10,000-25,000</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Pwani</td>
<td>&lt; 5,000</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Strathmore</td>
<td>&gt; 50,000</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>√</td>
<td>√</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Nairobi</td>
<td>&gt; 50,000</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>KEMU</td>
<td>10,000-25,000</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

KEY:

a-Contract negotiation; b-Patenting and licensing; c-Seeking and managing venture capital; d-Development and management of spin-off companies; e-Networking and seeking out external partners; f-Managing technology incubators; g-Managing science parks; h-Managing co-operatives with local business entrepreneurs.

The Table suggests that there are discrepancies between the budget items and the budgetary allocation, and that there is need for more reliable data from independent sources, such as the CUE or the DHE. For example, it is hard to imagine a dedicated university unit/office conducting all but two activities outlined above on a shoe-string budget of less than K.shs. 4, million! But this finding does concur with the observation by Ssebuwufu, Ludwick and Beland (2011:20) that structures dedicated
to linkages operate on minimal budgets, with low expertise related to IPR management and marketing strategies. Commercialization of knowledge and technology is an expensive venture and universities that are already strained of finances to sustain other more pressing activities may not allocate sizeable funds until the promise of returns is high.

4.3.5 Institutional Policies on Entrepreneurial Activities

To examine the extent of institutional policy support for activities that support an entrepreneurial culture within the respondent universities, the respondents were asked to report on the institutional policy framework for UIG linkages. The framework consisted of policies on time devoted to third mission activities such as research and consultancy, related matters on sharing and ownership of IP produced by academic staff, conflict of interest and other pecuniary issues, and mechanisms for evaluating effectiveness and profitability of linkages with the productive sector. Triangulation studies focused on locating the evidence of existence of such policies, and the researcher found them in Research and IP policies in at least in three of the study universities. These are reported in the following sections.

The first policy dimension has to do with the emphasis given to research among the other core missions of a university. Since universities have the multiple mandates to teach, conduct research and engage in community service, academic staff find themselves involved in all these activities. There was therefore need to find out if the respondent institutions had policies for regulating the time that academic staff are expected to dedicate to each of the university missions. Figure 4.12 presents findings on this item:
Figure 4.13: Responses on whether there is an institutional policy on proportion of time spent by academic staff on UIGLs missions

From the Figure, 10 (58.8%) respondents indicated that there are policies but no mechanisms for monitoring time. On the other hand, 6 (35.3 %) respondents indicated that there were relevant policies and mechanisms for monitoring time. In most universities in Kenya, there is more teaching going on than is research and transfer of knowledge and technology and this could explain the nascent awareness and development of elaborate policies on use of time by academic staff.

With regard to policy on sharing and ownership of IP produced by academic staff, respondents were required to respond to 6 possibilities. The findings are presented in Figure 4.14:
Do not know 6.3%

Other types of arrangements (please specify) 6.3%

Academic staff have exclusive ownership of intellectual property (IP) pertaining to their research 12.5%

Ownership of intellectual property (IP) is shared between the institution and academic staff 56.3%

The institution retains exclusive ownership of all intellectual property (IP) developed by academic staff 18.8%

0.0% 10.0% 20.0% 30.0% 40.0% 50.0% 60.0%

**Figure 4.14: Responses on whether there is an institutional policy on sharing and ownership of academic staff IP**

From the Figure, it is evident that almost all of the respondent universities (15.88%) did have a policy on sharing and ownership of IP produced by staff. Of these, majority of the respondents (10.67%) indicated that ownership of IP is shared between the institution and academic staff. This ensures that the academic staff benefit from their work but also that universities are acknowledged for the use of institutional research facilities and personnel (Ssebuwufu, Ludwick and Beland, 2011: 23). Joint IP ownership as a mechanism for resource mobilisation rather than exclusive inventor or institutional ownership is common in universities that are beginning to institutionalise commercialization of knowledge when compared with others that are more financially endowed with multiple income streams.
The third area requiring policy guidance has to do with a framework for determining costing and pricing for contract research and technical consultancy services. These are aimed at ensuring that academic staff continue to meet their teaching obligations while being able to benefit from income-supplementing work. Respondents were asked to indicate whether the institution had or did not have such a framework. The findings are shown in Figure 4.15:

![Pie chart](chart.png)

**Figure 4.15: Responses on whether there is an institutional framework on costing and pricing for contract research and technical consultancy**

From the Figure, 12 (70.6 %) institutions had such a framework while 2(11.8 %) institutions did not. This is an area that needs further research especially given the fact that most respondent universities indicated that they had a shortage of Contract/IP staff to develop such costing and pricing frameworks. In one respondent university, the legal office is responsible for such matters and such specialised expertise would be needed in a vibrant TTO, ILO or similar knowledge and technology transfer intermediary unit.
Further, there was need to establish whether respondent institutions had established guidelines on how royalties and other profits generated from collaborations with external actors are shared among staff, the institution, and third parties. Such guidelines are useful in minimizing tensions that can arise over claims to royalties. The respondents were asked to indicate whether these guidelines were available or not. The responses are reported in Figure 4.16:

![Figure 4.16: Responses on whether there are institutional guidelines on sharing of revenue from collaborations with external actors](image)

From the Figure, 9 (56.3 %) respondent universities had guidelines on how royalties and other profits from external collaborations were shared among the various actors, while 3 (18.8 %) did not. Again, this is an area that needs further research to triangulate such responses.
As a follow-up to the question above, respondents were asked to indicate how their institutions used profits, royalties and other monies. Their responses are reported in Table 4.7:

Table 4.7: Use of revenue from university-industry-government collaborations

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>As support to institutional budget</td>
<td>56.3%</td>
<td>43.8%</td>
</tr>
<tr>
<td>Saved in an institutional foundation</td>
<td>6.3%</td>
<td>93.8%</td>
</tr>
<tr>
<td>Paid out as bonuses</td>
<td>18.8%</td>
<td>81.3%</td>
</tr>
<tr>
<td>Remitted to the government treasury</td>
<td>0.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Re-invested</td>
<td>37.5%</td>
<td>62.5%</td>
</tr>
</tbody>
</table>

From the Table, the bulk of these pecuniary benefits (56.3%) were used to support the institutional budget, followed by re-investment into collaborations (37.5%), and then payment as bonuses (18.8%). It would appear most institutions did not have a foundation (6.3%), and none remitted the money to the treasury. As hypothesized earlier, most Kenyan universities have limited financial resources and use any available extra income to shore up the institutional budget.

With regard to policy on conflict of interest, that is, a situation when an individual or group’s involvement in one organization biases their ability to take impartial, independent actions in relation to another organization due to personal interest, respondents were asked to indicate the existence or otherwise of such a policy. The responses are reported through Figure 4.17:
The Figure indicates that 9 (52.9%) institutions have such a policy while 4 (23.5 %) institutions do not. As universities become increasingly entrepreneurial and results of research are commercialised through spin-offs or formation of joint venture companies, this is an important policy. University staff are most likely to be called upon to represent the university management in its portfolio of commercial ventures and the presence of such a policy would require the affected faculty to declare any such conflict. An interesting case in a respondent university is the appointment of the principal researcher in a commercialised venture as a director of the company. The development of elaborate policies to cover spin-offs from public R&D is needed as the entrepreneurial culture in Kenya evolves.

Finally, there was need to establish if the universities had any environmental policies that promoted or required individuals engaging collaboration with the productive sector to take environmental considerations into account. Respondents were asked to
indicate if such a policy existed, and their responses are reported in Figure 4.18 below:

![Bar Chart]

**Figure 4.18: Responses on whether there are environmental policies on university-industry-government collaborations**

From the Table, 10 (66.7 %) institutions reported that such a policy did exist, while 3 (20 %) institutions reported that they did not have such a policy. It would also be necessary to triangulate these findings so as to establish the scope of activity these collaborations covered that had environmental implications.

There was also need to find out whether the respondent institutions had any mechanisms to monitor or evaluate the profitability of its collaborations with the productive sector. A feedback mechanism is an important tool to evaluate the effectiveness and impact of university entrepreneurialism for institutional management, policymakers and private sector partners. Such mechanisms include a
feedback mechanism, external evaluation, among others. The responses are recorded in Figure 4.19:

![Pie chart](image)

**Figure 4.19: Responses on whether there are institutional mechanisms for monitoring effectiveness and profitability of linkages**

A half of the respondents reported having such a tool. Some respondents gave specific details of their feedback mechanisms. One respondent reported that the institution has an internal evaluation of results of collaboration. Another said that there were review and audit meeting at each stage of implementation of the collaboration venture. Still another indicated that the institution has quarterly performance appraisals which are state-supervised as a public institution, and also that there were ISO auditing sessions every six months (both external and external) to evaluate effectiveness and quality standards. Yet another respondent from a public university reported that the institution used reports from industry on sale of licenced products such as seed varieties, while the inclusion of industry in the Science Park Board provided feedback on strategies to better engage with industry as well as opportunities to tap into.
4.3.6 Linkage to a National and Regional Innovation System

In order to find out if the respondent universities were part of a national or regional innovation system or strategy for commercialization of research and therefore to provide a platform for government policy intervention and regional reach, the respondents were asked to respond to a question related to membership to such a system/strategy. A clarification definition of what a national or regional innovation system or strategy was provided in the instrument (Metcalfe, 1995). The responses are reported in Figure 4.20:

Figure 4.20: Responses on membership in a national or regional innovation system

The findings indicate that a majority (8 out of the 12, 67%) of the respondent universities were part of a NIS and RIS compared to 4 which were not. This prequalifies them to a valid discussion on the applicability of the Triple Helix model of commercialization of knowledge in general and within the manufacturing sector in particular. The knowledge outputs from the universities are commercialised within
this multi-stakeholder platform, whose nature and development impact in manufacturing is the focal point of this study. This now becomes the focus of the next section of this chapter.

4.4 Level and Type of Engagement with the Productive Sector

This section is the core component of the first research objective and indeed the research study as it concerns itself with the level and types of engagements that the universities had with the productive sectors of the economy, particularly the manufacturing sector. These sectors included: Agriculture and Agribusiness, Banking, Biotechnology, Business, Computer Engineering, Electronics, Engineering, Energy, Entertainment, Environmental management, Food processing, Hospitality and Tourism, Health Technology, ICT, Manufacturing, Mining, Pharmaceuticals, Water resources, and any other relevant category. Respondents were required to indicate the sectors in which their institutions had linkages, the activities and engagements, and the outcome(s) of such engagements. From their responses, the rest of the study zeroes in on those universities that indicated they had linkages with the manufacturing sector.

4.4.1 University-Industry-Government Linkage Sectors

From the provided list of the productive sectors outlined above, the respondents were asked to identify the one(s) that their institutions had engagements with. Their reports are outlined in Table 4.8 below:
Table 4.8: Sectors in which there are university-industry-government linkages

<table>
<thead>
<tr>
<th>Sector</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture &amp; Agribusiness</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>Biotechnology</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Banking</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Business</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Computer Engineering</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Electronics</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Engineering</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Energy sector</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Entertainment Industry</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Environmental management</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Food processing</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Hospitality and Tourism</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Health technology</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>ICT including software engineering</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Manufacturing in general</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Mining</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Water resources</td>
<td>2</td>
<td>15</td>
</tr>
</tbody>
</table>

Among the sectors listed above, the respondent institutions were most active in Agriculture and agribusiness, Environmental management, Biotechnology, Computer engineering, Energy, Food processing, and Water resources. Interestingly, they had less collaboration with manufacturing, pharmaceuticals, Electronics and Engineering, and Mining. In particular, only 5 universities, all public and older at that, had linkages with the manufacturing sector: Egerton, JKUAT, Kenyatta, Moi, and Nairobi. This is consistent with findings from an identical survey in Africa (AAU-AUCC, 2013:23) with those of the National Innovation Survey of 2013 (RoK, 2013) that confirms that the university is not the most frequent source of R&D or innovative ideas, and with
those of GII (2013) and the Global Competitiveness Report (2006-2007) that rate university-industry linkages in Kenya very lowly. Mugabe (2009:25) bases the explanation for this pattern on underfunding for research, research that is of little interest to industrial firms, the presence of in-house R&D units in TNCs, and low capacities of universities to manage IP.

Finally, when the respondents were asked if they were satisfied with the current levels of engagement with the productive sectors, most of them thought they could do more. This is shown in Figure 4.21:

**Figure 4.21: Responses on satisfaction with the current level of linkages**

From the Figure, 1 respondent was very satisfied, 6 respondents were somewhat satisfied, 5 were neither satisfied nor dissatisfied and 3 were somewhat dissatisfied. This generally low dissatisfaction is good as a basis for invigorating the development of further and more robust interactions between the university and its productive and policy environment.
4.4.2 University-Industry-Government Linkages with Other Organizations

In order to establish if the linkages reported above between the 5 universities and industry were two-way (dyadic) or complex, involving other actors, the respondents were asked to indicate whether they had ever had collaborated with such organizations as UNIDO, Science Research Councils, manufacturing associations, banking associations, Chambers of Commerce, MNCs, and SMEs. These actors in the innovation landscape indicate the entrenchment of a sound innovation system (Mugabe, 2009:29-37). Of the 5 universities, 4 of them indicated they have had interactions with international organizations, although they do not specify which ones. Again, four indicated that they have had collaboration with Science Research Councils, and two specifically mentioned working with the NACOSTI, which is a government agency. Again, 4 indicated that they have worked with manufacturing associations. A similar number reported working with state corporations. Only 3 of the 5 reported working with MNCs, and a similar number reported working with SMEs.

4.4.3 Outcomes of University-Industry-Government Engagements

In order to find out the actual activities these 5 universities have had with the productive sectors in collaboration with government, respondents were asked to indicate the industry-oriented engagements they had undertaken from a list of 11 options. The findings for the 5 respondents are reported in Table 4.9:
Table 4.9: Responses on the types of university-industry-government linkage activities

<table>
<thead>
<tr>
<th>Surveyed and evaluated the skill needs and capabilities of staff</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveyed the skill needs of industry?</td>
<td>3</td>
<td>60.0%</td>
</tr>
<tr>
<td>Identified investment opportunities and prepared feasibility studies</td>
<td>3</td>
<td>60.0%</td>
</tr>
<tr>
<td>Conducted short courses for industry personnel</td>
<td>3</td>
<td>60.0%</td>
</tr>
<tr>
<td>Conducted short courses for small-scale local entrepreneurs</td>
<td>2</td>
<td>40.0%</td>
</tr>
<tr>
<td>Organized seminars and workshops on industry-related issues</td>
<td>5</td>
<td>100.0%</td>
</tr>
<tr>
<td>Provided consultancy services to enterprises</td>
<td>3</td>
<td>60.0%</td>
</tr>
<tr>
<td>Supported technology incubators</td>
<td>4</td>
<td>80.0%</td>
</tr>
<tr>
<td>Supported science parks?</td>
<td>3</td>
<td>60.0%</td>
</tr>
<tr>
<td>Engaged in research and development of commercializable prototypes</td>
<td>5</td>
<td>100.0%</td>
</tr>
<tr>
<td>Supported development-oriented technology transfer for local communities</td>
<td>5</td>
<td>100.0%</td>
</tr>
<tr>
<td>Undertaken any other industry-oriented activities or other engagements with the productive sector</td>
<td>5</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

From the Table, seminars and workshops on industry-related issues, engaging in R&D of commercializable prototypes, support for the development of commercializable prototypes, support for development-oriented technology transfer to local communities, and support for technology incubators are the most common activities carried out by the five universities.
From the findings above, it was necessary to find out the outcomes of those engagements, positive or negative. For Egerton University, the positive outcomes were the raising of the university's profile, securing of funding for capital projects, student attachments, and commercialization of innovative products. The negative side was cases of initiatives that failed to start. For Kenyatta University, the positive outcome is the Chandaria Business Innovation and Incubation Centre. For the University of Nairobi, as a result of collaboration with the productive sector, students from the University of Nairobi-Science and Technology Park (STP) got an opportunity to participate in the *Milking the Rhino: Innovative Solutions Showcase*. The *Milking the Rhino* is an award-winning documentary produced by Kartemquin Films that examines environmental conservation from the perspective of people who live with wildlife and offers a complex, intimate portrait of two community based conservation efforts in Kenya and Namibia. The students got an opportunity to interact with other students’ teams across the world who were invited to articulate their understanding of the challenges faced by indigenous communities in Africa with regard to wildlife and natural resource management, conservation and sustainability. However, the downside was delays owing to bureaucracy in the procurement process of items that have almost caused donors to withdraw or withhold funding for sponsored projects. This is because it causes delays in delivery and surpasses timelines. An interesting observation at this point is that although the JKUAT does not report any positive outcome from engagements with the manufacturing sector, the researcher knows of a key innovation that is the outcome of academic entrepreneurship from the University-the JKUAT/NISSIN Noodles. This forms the subject of the next section that conducts an in-depth analysis of two of these outcomes.
4.5 **Motivations for the creation of UIGLs in the context of knowledge-based manufacturing**

The second research objective of the study was to find what the motivating factors for the creation of the reported linkages between the respondent universities, the manufacturing sector and government were. This required a closer examination of these linkages through focus on two aspects. First, the researcher studied a specific commercialization platform created from UIG linkage. Secondly, the researcher chronicled the commercialization experiences of an academic entrepreneur with an innovation that has been commercialized from university research and an analysis of their commercialization pathway. Cross-case analyses of these linkages would then involve examining the motive behind their initiation. The inclusion criteria for the choice of these case universities was an involvement in the manufacturing sector, affiliation to a national innovation system since the research study focuses on innovation in manufacturing that occurs through UIGLs, and the existence of an innovation platform and/or manufactured product.

From the previous part on the demographic profile of respondent universities and the researcher’s background research work, two universities need to be highlighted. One reported having a commercialization platform that could be studied in detail and the other had outcomes from UIG linkages that are related to commercialization of manufactured products. These are Kenyatta University with its Chandaria Business Innovation and Incubation Centre (CBIIC) and JKUAT with its JKUAT-NISSIN Noodles. The following section presents the commercialization experiences of these two universities. The presentation of the description is structured as follows:
i. A brief description of the case universities, especially the organization and management of the innovation process;

ii. A description of the commercialization platform/ the innovation;

iii. A description of the history of the commercialization platform/ product, including initiation, the role of various actors, the reasons behind the initiative;

iv. The process of commercialization; and

v. Challenges of commercialization and possible interventions.

4.5.1 Kenyatta University: Chandaria Business Innovation and Incubation Centre (CBIIC)

About Kenyatta University

Kenyatta University is a chartered public university in Kenya established under The Universities Act of 2012. It has a main campus located on the Nairobi-Thika super highway, and has campuses and centres in all parts of the country and in the East African region. The University’s momentous history began in the 1960s when the British Government handed over the then Templar Barracks to the Kenyan Government, which then converted the barracks into Kenyatta University College (Kenyatta University, 2010: 6). On August 23rd 1985, the Kenyatta University Act received Presidential Assent, a legislation that became operational on 1st September 1985. The University was inaugurated in December 1985. In 2013, the University became a chartered university as required by Section 13(1: 1870) of The Universities Act, 2012, an Act that repealed The Kenyatta University Act, Cap 210 C.
Organization and Management

Since then, the University has undergone tremendous growth to host 5 Colleges, 17 Schools, 73 departments, and 17 Directorates (Kenyatta University Statutes, 2013: 33, 78-80). It boasts of nearly 70,000 students, over 1,000 programmes/courses at all levels from diploma to doctorate and close to 1000 members of academic staff. The University is governed by the Kenyatta University Charter, 2013 which creates among others a University Council, a Senate and the University Management Board (Kenyatta University Charter, 2013:13-14). In Section 5 on Functions and Objectives, the Charter also spells out the functions of the University. The Kenyatta University Statutes details the officers who are involved in the management of the University, including the Chancellor, Chairperson of Council, the Vice-Chancellor, Deputy Vice-Chancellors, and Registrars, among others. Specifically, there is a Deputy Vice-Chancellor in charge of Research, Innovation and Outreach (Kenyatta University Statutes, Statute XI: 16). The Statutes also create Directorates working under the office of the Vice-Chancellor (Kenyatta University Statutes 2013:22-23).

Organization and Management of Research, Innovation and Commercialization

The highest organ in the organization of the research and innovation function at Kenyatta University is the Research, Innovation and Outreach Division, headed by a Deputy Vice-Chancellor. Established in 2014, it is the newest of the major divisions of the University, signalling the emphasis that the University places on research, innovation and outreach. This emphasis is already clear in the Kenyatta University Charter’s functions of the University. Those that are key to research and innovation include Section 5(1) a, b, c, d, e, h, i, j and p (Kenyatta University Charter, 2013:9-10).
They state the following:

i. Provide directly, or in collaboration with other institutions of higher learning, facilities for technological, professional, and scientific education;

ii. Advance knowledge and its practical application by research and other means;

iii. Disseminate the outcomes of research by various means, and commercially exploit the results of such research;

iv. Participate in technological innovation as well as in the discovery, transmission and enhancement of knowledge and to stimulate the intellectual life in the economic, social, cultural, scientific, and technological development;

v. Contribute to industrial and technological development of society in collaboration with industry and other organizations;

vi. Inculcate a culture of innovation in technology, engineering and science amongst staff, students, and society;

vii. Promote education in science, technology, engineering, and mathematics within the institution and society;

viii. Develop an institution of excellence in teaching, training, scholarship, entrepreneurship, research, consultancy, community service, among other educational services and products, with emphasis on technology and its development, impact and application to society;

ix. Promote critical enquiry and creativity in education, training and research within the institution.
Among the functions of this Division include to:

i. Drive the University’s research agenda in line with the Country’s Vision;

ii. Encourage research culture in the University;

iii. Institutionalise networking, collaborative research and outreach in the University;

iv. Encourage innovation; and

v. Encourage dissemination of research findings. (Kenyatta University Statutes 2013:16).

The Division is composed of 3 units: Research Support and Dissemination Unit (RSSDU), Research Monitoring and Budget Office (RMBO), and the University Research Advisory Board (URAB). A Registrar works directly under the DVC, but also performs duties assigned by the VC (Kenyatta University Statutes, 2013: 16-17). There are also directorates, centres and institutes specifically linked to the University’s research agenda: Centre for Intellectual Property Rights and Technology Transfer, Ethics Review Committee, Bio-Safety Committee, Grants Writing Unit, Centre for Teaching Excellence and Research Training, University-Industry Links and Partnerships, and Chandaria Business Innovation and Incubation Centre, (CBIIC). It is the CBIIC that forms the focus of this case, and to which this report now turns to.

Chandaria Business Innovation and Incubation Centre (CBIIC)

History of CBIIC

On the launch of the CBIIC, the VC of Kenyatta University pointed out the following:

*Kenyatta University has established a Chandaria Business Innovation and Incubation Centre in line with its Strategic and Vision Plan. The establishment of the Centre is a need driven initiative aimed at providing an environment that supports students to come up with new ideas and concepts and allow them to implement these into commercializable products. In addition to*
producing market-ready graduates, the Chandaria CBIIC will also foster knowledge transfer which involves the transfer of tangible and intellectual property, expertise, learning and skills between academia and the non-academic community.

In the same paper, the then Director, University-Industry Partnerships, under whom the CBIIC initially was, noted the following:

Since 1950s, the business and incubation concept has been viewed as a means to economic growth by many countries. World class universities have today partnered with their governments and/or the private sectors to establish incubation centres where innovative and entrepreneurial ideas are incubated and supported to maturity. Kenyatta University’s Chandaria Business Innovation and Incubation Centre shall therefore be a significant model that will carefully use technology and also inject capital and expertise to spur innovative and entrepreneurial talents. The Centre will also help in speeding up the commercialization of the start-ups upon maturity and link them with prospective partners for greater growth. With continued support by the public and private sector, the Chandaria-CBIIC is expected to be a significant vehicle towards Kenya’s social-economic transformation through creation of employment and wealth in line with the Kenya Vision 2010. This initiative is also in tandem with the continually emerging regional and global partnerships for development. Kenyatta University invites more partners support in this important initiative.

In its most current brochure, the current Director of the CBIIC provides the following introduction on the concept of the Centre:

Kenya’s Vision 2030 calls on Kenyans to be active participants in job creation for socio-economic development and national transformation. This can only be achieved through efficient and effective management of innovations, which provide Kenya with unparalleled opportunities for economic growth and development. The upsurge in scientific and technological knowledge can only provide economic and social benefits when it is effectively exploited to lead to innovation. Innovation has been identified as a key driver of long-term economic growth, the primary basis for competitiveness in world markets and part of the response to many societal challenges (unemployment, sustainable development, etc.).

The ‘university incubation’ concept is a popular practice among World Class Universities and its origin is traced to the 1950s in the US. To date, this concept has been embraced widely as a
stimulus for socio-economic development both in Western and Eastern parts of the world. Similarly, the overall goal of Chandaria CBIIC, which operates on a Public-Private Partnerships basis, is to lead to a national socio-economic transformation through wealth and employment creation.

Thus, it can be noted that the Chandaria CBIIC concept is rooted in the development framework guiding the country’s development, the Kenya Vision 2030 with its emphasis on job creation for economic development and national transformation as well as the use of PPPs to make Kenya Vision 2030 a reality. It is also rooted in the Kenyatta University’s Vision and Mission Plan. In Chapter 5 on Research, Science, Technology and Innovation, the Strategic Plan specifically notes the following by way of putting the concept of incubation in context:

*Research is an important catalyst for development in a country. Kenya's Vision 2030 and in line with MDGs recognizes that creation, adaptation and use of knowledge are among the critical factors necessary for rapid social, political and economic growth and development. The emergence of the knowledge-based economy is associated with an increase in research, science, technology and innovation (RSTI) related activities critical to the socio-economic transformation of the country. ...Kenyatta University endeavors to be a centre of excellence for research, generation of knowledge and development in new technologies. The knowledge produced will continue to be transformed into technologies and innovations to meet the needs of society.* (Kenyatta University Strategic and Vision Plan, 2005-2015: 33)

The second among the flagship projects in this area is the establishing and equipping of ‘business innovations and incubation centre’. Other projects include ‘Industrial and Science Park’, Science and Engineering Workshops’, and ‘Recreation Centre’. The strategic goal is to promote RSTI, the pertinent strategic objective is ‘promote and develop business ideas and innovations’, attained through the ‘establishment of a business innovation and incubation centre’, leading to ‘increased number of business
ideas and innovations’ (Kenyatta University Strategic and Vision Plan, 2005-2015:33-34). True to the projections in the log frame to establish such a centre in its second cycle (July 2010-June 2015), the Kshs. 121 million facility was constructed with funding from both the University and the Chandaria Foundation between July 2012 and July 2013, and was officially opened on 30th July 2013. Below are photographs of the facility:

**Figure 4.22: Entrance to the Kenyatta University Chandaria Business Innovation and Incubation Centre, CBIIC**

*Structure, Organization and Management*

In order to institutionalize the CBIIC, the VC appointed a Board headed by a chairperson and constituted by University faculty and representatives of various partnering organizations. The key players are the University, distinguished mentors, professional mentors and the Innovators. The daily operations of the Centre are
handled by a Director who reports both to the Board and the VC. A Strategic and Vision Plan (2013-2017) and a CBIIC Policy (2013-2017) have been developed. The Plan aims at helping the University to jointly pool its resources to achieve its business innovations and incubation goals and objectives. The Policy was developed to ‘guide and regulate the activities of incubates, mentors, the Board and other stakeholders’ (KU-CBIIC Policy 2013-2017:7). The areas covered by the Policy include application and admission procedure, admission and facilitation, mentoring, M&E, patenting/copyrighting, administration and management, partners and stakeholders and miscellaneous provisions. The CBIIC has a website: http://www.ku.ac.ke/chandaria-biic/, which hosts information on the KU-CBIIC, application procedures, incubation services, Innovators’ Non-Disclosure Agreement, and updates on progress at the Centre.

The objectives of the CBIIC are:

i. To blend academic research and training with innovation and incubation.

ii. To predispose Kenyatta University’s staff, students and others towards being employment and wealth creators.

iii. To promote Public-Private Partnerships (PPPs) amongst the University, business community and other stakeholders.

iv. To provide a model business and innovation incubator replicable locally and internationally.

v. In its Strategic Plan 2013-2017, the CBIIC outlines its strategic objectives as:

vi. Create a demand for innovation and incubation services rendered at CBIIC;

vii. Provide highly effective innovation and incubation services in line with international best practices;

viii. Develop an exit strategy for incubated ideas and businesses;
ix. Strengthen and expand innovation and incubation services delivery using the virtual platform;

x. Build human resources capabilities for effective delivery of innovation and incubation services;

xi. Establish a collaboration framework between CBIIC and partners;

xii. Establish a robust planning, research, monitoring and evaluation framework and mechanism; and

xiii. Develop a sustainability framework of operations.

The funding of operations at the CBIIC is mainly done through the University management, the University's equity share in incubate firms that are generating revenue, partners (UWEZO Fund, Chandaria Foundation, Youth Enterprise Development Fund), non-profit organizations (KIVA Micro Funds) and grants from the corporate sector as CSR, and some of the country's development partners.

The Commercialization Process

An incubator is a program that supports new business formation by providing a comprehensive range of business support services to entrepreneurs and start-up companies. Support provided to early-stage companies is designed to help these businesses survive in the marketplace once they graduate from the incubator program. Incubators are often used to strengthen cooperation between public and private actors. At KU-CBIIC, the incubation starts with a prospective incubate responding to the internal and external marketing efforts of the CBIIC through posters, radio, newsletters, memos, the print and social media, and fora to talk to the general public what CBIIC is all about. Interested parties then visit the website and download a self-explanatory application form, duly fill it in and submit it in line with provided
thematic areas. A team of reviewers sits to review the ideas to examine which ones are innovative, novel and which ones are not, working closely with Centre for Intellectual Property Rights and Technology Transfer for patent searches. They also evaluate it on its commercial viability, potential to change lives, and the requirements to develop it to maturity. The shortlisted applicant is then invited for an interview, explains the idea, and if successful is admitted into the Centre. Depending on whether the successful applicant is an outsider or a Kenyatta University student, the successful applicant then signs a customized contract developed with the help of the University's legal office, a Code of Conduct and a Non-Disclosure Agreement on confidentiality of information received. A mentor is then assigned to the incubate.

The incubation model consists of three stages: entry level; R&D/BDS, and field visits; pitching. Level 1 ideas are skilled businesses, Level 2 ideas are developed prototypes, while Level 3 ideas are ideations. Depending on the entry level, there are variations in the stages. Level 1 entry's stages involve: Stage 1-vetting, admissions, registration; Stage 2-Field visits, contacts with technical mentors, peer mentoring, fire camps, personal mentoring; Stage 3-Exit pitching. Levels 2 and 3 are almost identical to Level one save for the R&D and Business Development Training, and the duration. Level I takes 5 months, Level 2 takes 8 months and Level 3 takes 11 months.

The incubation process brings together three key players: Kenyatta University, the innovators and mentors both distinguished and technical.

According to its brochure, CBIIC clarifies the University’s facilitation role to consist of providing the innovators with the following:

i. Space, equipment, high-speed internet access

ii. Daily administrative and managerial assistance
iii. Mentorship

iv. Assistance with business basics, accounting/financial management, comprehensive business training programmes, business etiquette

v. Networking activities, links to strategic partners,

vi. Marketing assistance

vii. Access to bank loans, loan funds and guarantee programmes, angel investors or venture capital

viii. Presentation/pitching skills

ix. Management team identification and advisory boards

x. Technology commercialization assistance

xi. Assistance with regulatory compliance, IPR management

xii. Links to higher education resources

There are two categories of mentors: distinguished and technical. The former consist of renowned Kenyan entrepreneurs such as industrialists, CEOs of public and private corporations, top businessmen and women, among others. Professional or technical mentors are a team chosen from among teaching staff to guide the innovators on their innovations daily till maturity. Due to the complex nature of the undertaking, the CBIIC brings together numerous partners in a true PPP approach. They consist of individuals, corporates, and government. Currently, these partners include, among others, the Chandaria Foundation, the Royal Media Group, Telkom Orange, SELCO, IRENA, Phillips, the Centre for Innovation and Incubation Entrepreneurship, SME Survey, Intellecap, the University of Ontario, the Youth Enterprise Development Fund, the NACOSTI.
Outcomes

In its July-December Progress Report, the Director of CBIIC reported the following achievements that are relevant for manufacturing:

i. Supported the application of patents through the relevant Kenyatta University’s IPRs Directorate;

ii. Contacted possible users of products from companies housed at CBIIC for the purposes of testing, endorsement, and getting firm orders;

iii. The following companies have been generating revenues from products already in the market and are about to graduate: Ben and Johnson with biogas kits and energy product; OEB Limited with unique energy briquettes, ROCCO Group with coconut oil and drink, and SPENK Industries with a potty cleaner, a detergent.

Figure 4.23: Incubate spaces for Electronic Chopper and Rocco Companies
Challenges to Commercialization of Innovations

According to the Co-ordinator of CBiIC, there are two key challenges: changing the attitude of innovators to disclose proceedings from their businesses, seed capital to develop ideas and production. Disclosure is important because it signal that the innovators have had positive outcomes from their stay in the incubator. It is also an important signal to partners that their support of this otherwise expensive venture is worthwhile. Innovators also need seed capital to nurture their ideas to maturity.

There is need to invest in space and facilities for full-scale production of the ideas and products from the incubator, such as a science and industrial park to commercialize research and technology. The incubator is limited to merely providing an office, a physical address and other basic forms of support. Such a production facility does not have the scope of contributing more directly to a knowledge-based economy due to the limited scale of production and technology employed.
In the CBIIC Progress Report, July-December 2013, other challenges identified include commitment of technical mentors, capacity to deal with growing demand for incubation services, availability of financial support for the growing number of incubates, procurement of further support infrastructure such as a 3D printer, a web-based communication system to reduce security threats, and finalization of MoUs.

**Responses and Prospects**

The challenges of a science and technology park and of an industrial park are currently being addressed by the University management. In the launch of the CBIIC, the Vice-Chancellor appealed to the Cabinet Secretary, Ministry of Education, Science and Technology to help the University acquire land for these facilities as they are already envisaged in the Kenyatta University Strategic Plan 2005-2015. The University has already set aside 60 acres of land for the STP, and the process of planning for it is already going on under the Directorate of University-Industry Linkages.

4.5.2 Jomo Kenyatta University of Science and Technology: JKUAT-NISSIN Foods

**About JKUAT**

The JKUAT is another of Kenya’s public university. It has a main campus located at Juja, 36 kilometres to the North-East of Nairobi close to the industrial towns of Ruiru and Thika. It also has campuses in 11 locations in and outside Kenya, and numerous collaborating institutions. It was founded in 1981 as a middle-level college following a technical arrangement between the Governments of Kenya and Japan through the Japanese International Co-operation Agency (JICA) spanning a period of 20 years till
2000. As a college, it awarded certificates and diplomas in Agricultural Engineering, Food Technology, Horticulture, and Civil/Mechanical/Electrical Engineering. In 1988, it was elevated to a constituent college of Kenyatta University and consequently changed its name Jomo Kenyatta College of Agriculture and Technology to Jomo Kenyatta University College of Agriculture and Technology. In 1994, an Act of Parliament transformed JKUCAT into a full-fledged university, the Jomo Kenyatta University of Agriculture and Technology (JKUAT). On 13th December 2012, the Jomo Kenyatta University of Agriculture and Technology Act No.8 of 1994 was repealed and, as noted in the case of Kenyatta University, the University is now governed under the Universities Act, 2012.

**Organization and Management**

From an initial enrolment of 70 in 1981, the University has grown tremendously (Ng’ethe and Ngome, 2006:15-18). Currently, it has a population of over 30,000 students and offers certificate, diploma, undergraduate and postgraduate programmes in Agriculture, Engineering, Technology, Enterprise Development, the Built Environment, Health Sciences Social and Applied sciences. These programmes are offered in 2 colleges, 3 campuses, 7 schools, and 3 institutes: College of Engineering and Technology (COET), College of Health Sciences (COHES), Faculties/Schools of Agriculture; Architecture and Building Sciences (SABS); Human Resource Development (SHRD); Mechanical, Manufacturing, and Materials Engineering; Civil, Environmental and Geospatial Engineering; Electrical, Electronic and Information Engineering; Institute of Computer Science and Information Technology (ICSIT), Institute of Energy and Environmental Technology (IEET), and Institute of Biotechnology Research (IBR).
The University aims at being a University of global excellence in training, research and innovation for development. Its main objectives are:

i. To provide in collaboration with other institutions, facilities for agricultural, technological, scientific, and professional education;

ii. To participate in the discovery, transmission and preservation of knowledge and to stimulate the intellectual participation of students for economic, technological, agricultural and cultural development of Kenya;

iii. To be proactive in the development of agriculture and technology in conjunction with industry and to promote extension services for national development; and

iv. To examine and make proposals for the establishment of new departments, resource and research centres, new degree courses or new subjects of study.

**Organization and Management of Research, Innovation and Commercialization**

The highest organ in the management of research at the JKUAT is the Research, Production and Extension (RPE) Division, set up in 1987 when JKUCAT became a constituent college of Kenyatta University. Then, it was headed by a Deputy Principal. When the University became a full-fledged University, the headship changed to a Deputy Vice-Chancellor (DVC-RPE). The office of the Deputy Vice-Chancellor co-ordinates the following activities:

i. Research, fundraising and dissemination;

ii. Production and income generating activities;

iii. Extension, e.g. through shows, exhibitions;

iv. Linkages with local and international organizations;

v. Community collaboration.
These mandates are performed by various Directorates, Institutes, Centres, and Department: Directorate of Research and Innovations; Directorate of Extension and Technology Transfer; Directorate of Production; Directorate of Linkages; Institute of Energy and Environmental Technology (IEET); Institute of Biotechnology Research (IBR); Sustainable Materials Research and Technology Centre; Sino-Africa Joint Research Centre; Water Research and Resource Centre (WAREC); and the Chemistry Products Centre; and the Department of University Community Collaboration.

Commercialization of Knowledge and Technology at the JKUAT

In a very bold statement of JKUAT’s commitment to commercialization of research findings and innovations, the Director of Research made the following comments:

> Our goal as a University is to produce leaders and not job-seekers—people who are able to use their knowledge and skills to develop enterprises. With the industrial park in place, we will be able to let the public, students and researchers identify specific products imported into our market, learn how they are made and use the knowledge to spur innovations. JKUAT may not upscale and commercialize some of its products but will collaborate with other institutions like Kenya Industrial Research Institute (KIRDI) and Kenya Industrial Estates (KIE) who have the capacity and capabilities to do that. At JKUAT, we are working towards being the leader in commercialisation of innovations at the same time being open to share the success story with other universities. The University spends Kshs. 52 million (US $ 608, 400) annually on research and innovation.

In February 2012, the JKUAT rolled out plans to build a Kshs.3 billion (US $ 35.1 million) Industrial and Technology Park, the Nairobi Industrial and Technology Park, in partnership with the Ministry of Industrialization and Enterprise Development. This is the first in the East Africa region and a Kenya Vision 2030 project housing a manufacturing plant, a research centre and incubator bases for SMEs. Agro-processing, agro-machinery, electric and electronics, metal, bio-technology, ICT, and
packaging manufacturing firms will be given priority. The facility will also contain a technology museum. The research unit will actualize inventions based on research findings as well as foster commercial uptake of new technologies.

The University has been recognized for its innovative culture, with innovations in agriculture, chemical industry, engineering, and food processing. These include the tissue cultured bananas, three-wheeler motor cycles, bricks block-making machine, tick-trap machine, plant mills, fruit pulp, juice extractor, maize collector, cosmetics, disinfectants, paints, wood preservatives, yoghurt, wines, fruit juices, jam and now instant noodles. These are produced in small scale, though there are plans to produce them in mass scale. Towards this end, venture capitalists are being sought to finance such production. Already one has been found to partner with the University to set up a fast food company in the University’s premise. It is to this venture company, the JKUAT-NISSIN Foods Ltd. that this discussion turns to.

**The JKUAT/NISSIN FOODS Ltd.**

**History of JKUAT NISSIN FOODS Ltd.**

JKUAT partnered with Nissin Foods Holdings Co., Ltd. Of Japan and established a joint venture company called JKUAT NISSIN FOODS Ltd. The partnership started in 2008 as a Nissin Foods Holdings Corporate Social Responsibility (CSR) activity in the form of a School Feeding Programme through the Ministry of Education on Nissin’s 15 year anniversary of being in business. Through the JICA, JKUAT was picked as a local partner. Nissin donated machinery for small scale production and using a laboratory in the University, started production for the schools around the institution. This ultimately led to the development of locally customized, high quality instant noodles for the Kenyan market through the University’s Department of Food Technology (FOTEC).
The next phase of the collaboration was an expression of the desire to commercialize the production of the noodles by the University. Negotiations between the University and the Japanese parent company led to the establishment of a joint venture private company. Approval was given by the Government and the company was incorporated in January 2013. Nissin Holdings invested Kshs. 350 million as the main shareholder and JKUAT Kshs. 150 million in a 70-30 partnership. Operations commenced in June 2013 and the instant noodles hit the market in October 2013. The University has already set aside land for the project and a factory is in the process of being set up for local production. Currently production is being done in India in a Nissin subsidiary using the Kenyan recipe. The photograph below shows the offices of the firm:

Figure 4.25: Outside the JKUAT-NISSIN Noodles company premises at the JKUAT and the Managing Director, Mr. Daisuke Okabayashi
Structure, Organization and Management

JKUAT NISSIN FOODS Ltd. is a private venture company whose aim is to manufacture healthy, convenient and affordable instant noodles for the market. Its daily operations are run by a Managing Director from Japan’s parent company while JKUAT is represented by the key academic entrepreneur from the Department of FOTEC. JKUAT has been instrumental in facilitating the setup on such matters as environmental compliance, connection to utilities, among others. The Managing Director oversees the delivery of the product to JKUAT from the Indian subsidiary and its subsequent distribution to the supermarket chains around Nairobi as well as to local distributors. The Director, a specialist in Finance and Marketing, has a marketing manager and a skeleton staff from the University. The company has its offices and small storage go-down in the University. Below is a photograph of the company’s marketing materials:
Figure 4.26: Marketing banners outside the office of the FOTEC Director at the company

According to its marketing brochure,

*In line with the Kenya Vision 2030 agenda, JKUAT NISSIN FOODS Ltd. is committed to contributing towards national industrial growth and the Kenyan market, as it aims to tap into and develop local skills, offering employment in its locally based manufacturing plant. The high quality instant noodle product will also contribute to food security in Kenya by virtue of being affordable, healthy, nutritious and convenient. The joint venture company is also a clear demonstration of the Public-Private Partnership (PPP), which has been recognized as an important vehicle for rapid economic growth. Furthermore, the establishment of JKUAT NISSIN FOODS Ltd. is in line with JKUAT's strategic vision...*

The instant noodle are uniquely derived from Atta and sorghum flours unlike other noodles that are usually made from white wheat flour, and has uniquely Kenyan chicken and roast meat flavours. In the company’s information booklet, the following aspects of the noodles are emphasized:

*They are developed at JKUAT and meet the nutritional requirements and taste properties desired by Kenyans. They are rich in minerals, proteins and fibre. They are made by Kenyans, utilizing appropriate research, technology and quality assurance. The collaboration between JKUAT and Nissin on instant noodles business brings together expert knowledge and high technology. Nissin company of Japan is the world's first instant noodles manufacturer and JKUAT is a reputable university in Food Sciences*

*The Commercialization Process*

JKUAT NISSIN NOODLES Ltd is an example of a joint venture company created for the purpose of commercializing research findings. The transition from a CSR initiative to considerations of commercialization involved collaborative research teams from both Nissin and JKUAT thinking of a product that had a unique local
taste. Thus Nissin’s experience in the manufacture of instant noodles and a sizable FDI injection and JKUAT’s experience with food science in a local setting merged to innovate noodles with a Kenyan flavour, made with Kenyan flours and flavour. The packaging of the noodles was developed in Japan but the product concept and design were done with the local market in mind. Nissin Holdings, Inc. holds the Nissin trademark as an industrial design, but the Kenyan recipe is not patented and remains a company secret. The local company logo and trade mark are registered in Kenya.

Once the mass production commences, the flour for the instant noodles will be sourced from local farmers and milling companies that meet their cost and quality requirements. The Managing Director hopes to use the JKUAT’S quality brand influence to penetrate the local market. The company set-up process is the same as other companies with regard to tax responsibilities, environmental compliance, among others.

Below are photographs showing the JKUAT-NISSIN Noodles:

**Figure 4.27: Packets of the JKUAT-NISSIN Noodles on display**
Motivation for Commercialization of Innovations

From responses to the Standard Innovation Questionnaire used in the Oslo Manual’s Community Innovation Surveys, the Managing Director identified the following reasons for innovation:

i. Enter new markets
ii. Increase market share
iii. Improve the quality of the product
iv. Increase the range of products by the parent company

For the University, this was an opportunity to showcase efforts in commercialisation of R&D outcomes, to promote the JKUAT brand, generate income streams, and motivate faculty to be engaged in knowledge and technology transfer.

Challenges to Commercialization of Innovations

According to the Managing Director, one of the challenges lies in the novelty of noodles in the Kenyan market. Thus, the company spends considerable sums on sales and promotion through local displays and advertisement so as to beat the competition as well as penetrate the Kenyan consumer through its unique supply chain of small shops and supermarkets.

The other challenge is how to make a profit in light of competition from other established competitors such as Indomill and Nestle. Thus the Managing Director collects market data in order to determine the most appropriate market price. Associated with this is the wrong impression that having a Japanese manager is an automatic guarantee to profitability as is the case with known Japan brands as Toyota or Sony. Management has to be rigorous especially due to costs of skilled labour,
utilities, fuel among other operational overheads, which the Managing Director feels are comparatively high.

From responses to the Standard Innovation Questionnaire used in the Oslo Manual’s Community Innovation Surveys, the Managing Director identified further challenges to commercialization and triangulated those already identified:

i. Lack of qualified personnel

ii. Lack of information on markets

iii. Market dominated by established enterprises

iv. Limitation of science and technology policies

4.5.3 Cross-Case Analysis of the Case Studies

This section turns to the core task of this research objective, which is to analyse the motivations for the creation of linkages between universities, manufacturing industry, and the government in the context of knowledge-based manufacturing. In order to do so, a cross-case analysis was performed on the two cases of commercialization of innovations by the two study universities. The analysis was guided by the following sub-themes: institutional profiles of the case universities; institutional arrangements and interface structures for commercialization of the innovations; institutional policies with regard to commercialization of innovations; funding; motivations for commercialization; outcomes for manufacturing; enabling factors, challenging factors, and, support services needed.
Institutional Profiles

Apart from the fact that JKUA T was initially a constituent college of KU, the two institutions have evolved on separate paths to become entrepreneurial universities. JKUAT, as its name suggests, developed from a clear orientation to agriculture, science and technology whereas KU started as a teacher education institution. However, over time both institutions have mounted comprehensive programmes that range from diploma to doctoral levels, and that also cut across professional orientations: engineering, ICT, medicine, human resource development, agriculture, among others. Both have also experienced phenomenal expansion in student enrolments. However, JKUAT has a better academic staff: student ratio at 1:11 compared to K.U.'s 1:63. Both universities also have postgraduate programmes. Both are managed under the provisions of The Universities Act, 2012.

Institutional Arrangements and Interface Structures

Both institutions have strategic plans and these plans have explicit reference to building linkages with the productive sectors. Both institutions also have divisions that explicitly promote research, innovation and knowledge transfer. This division is older at JKUAT since it was created at the inception as JKUCAT. The one at KU is very new, having been established at the beginning of 2014, although the culture of research is as old as the University. Both institutions have dedicated units to deal with linkages with the productive sector and to commercialize their knowledge products. JKUAT has the Industrial Liaison Unit in the VC’s office. K.U. has the Directorate of University-Industry Linkages under the VC’s office. It is the Directorate that was the first housing for the CBIIC before it became a separate entity. The JKUAT-NISSIN FOODS Ltd. is a private joint venture company housed in the University. Both
structures are remarkable outcomes of PPP. Whereas CBIIC is based on a mentorship model that seeks to incubate ideas from students, the JKUAT-NISSIN Noodles Company is an outcome of joint public and private R&D activities. Thus, the CBIIC has become a hub for students from other universities without a similar facility, and is also a platform for University faculty to transfer knowledge to the mentors and their business concepts and to accumulate valuable experience and social capital in the form of tacit knowledge. The University has an opportunity to develop IP experience in the course of facilitating the acquisition of IPRs for the incubates, deepen contract development skills for materials transfer, sharing of costs and revenue, marketing, and promotion of the University' brand.

**Institutional Policies**

Both institutions have put matters of research and innovation in a series of institutional policies. Both universities have a Research Policy, under which most issues to do with research and IPR are located, although K.U. has also developed a separate IPR Policy. The CBIIC has also developed its own policy.

**Funding**

With specific reference to the University-Industry-Government linkage platforms, the two institutions have different models. The CBIIC at KU is chiefly a PPP project bringing together the University and the Chandaria Foundation for its construction but involves multiple stakeholders to fund its operations, including government departments and agencies. The JKUAT-NISSIN FOODS is a joint venture company that brings together university and private equity in a 70:30 shareholding arrangement. Its roll-out in the manufacturing phase will involve the MoIED in its construction.
Motivation for Establishment

Although both initiatives have explicit mention of attainment of Kenya’s Vision 2030 though their activity, the realization that this is one way of promoting the creation of a knowledge-based economy through SME incubation comes much later in the case of KU, but is not explicitly mentioned in the case of JKUAT-NISSIN FOODS Ltd. Both, however implicit it might appear, are based on the transfer of knowledge embodied in mentors and in an innovation, resulting in products in the market.

Outcomes for Manufacturing

JKUAT-NISSIN FOODS is an innovation in agro-processing. For K.U. the 7 SMEs companies graduating from CBIIC have innovations in agro-processing (ROCCA Group’s coconut oil and energy drink, petroleum and other chemicals (SPENK’s potty cleaner), wood and cork products (OEB’s unique energy briquettes, BEN& JOHNSON’s Biogas kits and energy product.

Enabling Factors

In order to understand the reasons explaining the successful outcomes reported above, the researcher triangulated the findings of the UIGL survey with the interview reports from research managers in the two institutions. In both institutions, the explicit promotion of UIGLs in institutional priorities and the existence of a central office to provide support and co-ordination were factors that have played the most significant role in fostering the UIGLs. For JKUAT, additional factors included hiring and promotion of faculty linked to industry-related research and/or entrepreneurial activities, and government funding. For Kenyatta University, the additional enablers were: expressed support from the University’s Council, and the presence of academic and professional staff with entrepreneurial experience.
Challenging Factors

Once more, in order to triangulate the interview reports on the most significant challenges facing the two universities’ efforts to strengthen UIGLs, the researcher identified these from the survey findings. The respondents had two common factors: apathy from academic staff and lack of entrepreneurial skills and knowledge among academic staff. For JKUAT, the additional challenges came from factors such as inadequate research infrastructure (e.g. labs), lack of commercialisable products, and lack of established networks with the productive sector. For Kenyatta University, limited capacity to market research outputs was the additional challenging factor.

Support Services Needed

Thus from the section above, there was need to find out which support services were deemed to be needed from government and other stakeholders to strengthen institutional capacity to strengthen UIGLs. Both institutions identified two support services: training for academic staff in entrepreneurial skills and funds to commercialize research outputs. It was a bit strange that Kenyatta University did not indicate that it needed support for establishing technology incubators and/or science parks especially considering the critical value of science parks. However, if it uses the PPP model used in the CBIIC, it can still manage to pull the proposed construction of the STP.

JKUAT had unique extra services needed to enhance its institutional capacity to strengthen UIGLs: opportunities to learn from institutions with a history of strong engagement with the productive sector; training for middle and upper management in building external relations, especially the productive sector, and the development of
curricula that promotes entrepreneurial skills. For Kenyatta University, conferences or other events to help HEIs to network with African enterprises and key actors in the productive sector was the needed support service.

### 4.6 Extent to which the UIGLs can contribute to the development of knowledge-based manufacturing in Kenya

This section examined the mosaic of the national innovation system's institutional, legal and policy framework in reference to manufacturing so as to answer two questions:

i. Is there evidence of co-evolution in the institutional spheres to support the emergence of a knowledge-based manufacturing sector in Kenya?

ii. To what extents are the universities in Kenya playing the driving role as predicted by the Triple Helix theory?

This was be done by a brief description of both the national innovation system in manufacturing and through an analysis of temporal and structural interconnections in the institutional spheres in the course of the commercialization of the university knowledge outputs in the economy and within the policy context of the First Medium Term roll-out phase of the Kenya Vision 2030.

#### 4.6.1 The National Innovation System for Manufacturing in Kenya

Metcalfe (1995), an innovation system consists of the set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of
interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies. In the context of manufacturing, this consists of the various actors who facilitate the institutionalization of innovation in the manufacturing sector and the various mechanisms of co-ordinating their efforts to enhance effectiveness and impact. In this study, these actors are the government and its various agencies, the science system and industry players. Their various functions were described earlier and this section focuses therefore on how they are currently functioning in mainstreaming innovation in manufacturing and whether their efforts serve to enhance the evolution of knowledge-based manufacturing in Kenya. The government actors consist of ministries and their agencies, the industry is represented by manufacturing enterprises and affiliated associations, while the science system is represented by universities. The specific focus of the first section is to describe the network of actors in the Kenyan innovation scene in manufacturing while the second one examines whether the efforts described in the previous section by the two case universities fit in and contribute to the emergence of a knowledge-based manufacturing sector.


Ministry of Devolution and Planning

The place of manufacturing in Kenya is emphasized in the Kenya Vision 2030, the policy blueprint that guides national development in Kenya. The Kenya Vision 2030 was developed jointly by the National Economic and Social Council (NESC) and the then Ministry of Planning and National Development in 2007 after the lapsing of the then blueprint, the Economic Recovery Strategy for Wealth and Employment
Creation, 2002-2007 (ERS). Its implementation commenced in 2008. Currently, the implementation of Kenya Vision 2030 is co-ordinated under the Ministry of Devolution and Planning. The Cabinet Secretary heads a Kenya Vision 2030 implementing ministries subcommittee that reports to the President. The Cabinet Secretary does the co-ordination through the Kenya Vision 2030 Delivery Board constituted by the Principal Secretaries of the relevant ministries and key private sector players. The Delivery Board has a secretariat that co-ordinates the various ministries and is headed by a Director General. The Secretariat has two core divisions: Kenya Vision 2030 Pillars/Foundations and Administration. The Kenya Vision 2030 Pillars division has three sections in accordance with the Vision’s Pillars-Social, Economic, and Political. It is responsible for the co-ordination of the Vision’s flagship projects to ensure timely completion, receives recommendations on projects that can be up-scaled to Vision 2030 flagship projects, performs analysis of the potential impacts of flagship projects to development, prospects for funding for these projects, makes recommendations on the relevant legal and policy requirements for the implementation of these projects, among others. The Division performs this role through respective line ministries, which have ministerial secretariats headed by a Sector Director or an equivalent with a dual reporting structure, both to the Principal Secretary in the relevant Ministry and to the Director-General, Kenya Vision 2030. Further, in order to ensure that the Vision is implemented in county governments, the Division has County Kenya Vision 2030 Committees.

Ministry of Industrialization and Enterprise Development

With regard to manufacturing, the mandate to drive the agenda is the Ministry of Industrialization and Enterprise Development (MoIEd). The Ministry is headed by a
Cabinet Secretary who is responsible for policy, and who is assisted by a Principal Secretary as the chief accounting officer. The Ministry has 7 departments: Industrialization; Manufacturing and Vision 2030; Micro and Small Industries; Medium and Large Industries; Industrial Research and Information; Industrial Property Tribunal; and the Standards Tribunal. There are 14 State Corporations under the Ministry: the Counterfeit Agency; East African Portland and Cement Company; Export Processing Zones Authority; Kenta Accreditation Service; Kenya Bureau of Standards; Kenya Industrial Estates; Kenya Industrial Research and Development Institute, Kenya Industrial Property Institute, Kenya Investment Authority, Kenya Wine Agencies, Micro and Small Enterprises Authority, New Kenya Co-operative Creameries, Numerical Machining Complex, and the SACCO Societies Regulatory Authority.

For manufacturing, the vision is to ‘develop robust, diversified and competitive manufacturing’ through strengthening of the local production capacity to reduce import dependence, raising of the market share of Kenyan products in the regional market, and developing niche products for the global market especially in agro-industrial industries in partnership with strategic investors (RoK, 2007:60-65). Kenya Vision 2030 projects and initiatives as outlined in the Vision are: development of industrial and manufacturing zones and of SME parks. Other initiatives are:

i. Reform of the industrial structure;

ii. Strengthening of negotiation capacity and building of strong trade agreements;

iii. Strengthening of import regulations;

iv. Encouraging domestic and foreign investors in clusters;

v. Promotion of STI;
vi. Improvement of critical infrastructure; and

vii. Improvement of the business environment

Interestingly, this list omits other initiatives captured by the Assistant Director in the Economic Pillar at the Kenya Vision 2030 secretariat. These are:

i. Construction of steel mills to lessen dependency on imports and scrap metal, and meet a growing demand for steel in the economy;

ii. Training of engineers and technicians so as to raise the engineer/population ratio from 1: 7, 000 to 1:300.

iii. Strengthening the capacity of KIRDI into a robust research institution and expansion of presence of KIRDI across the 47 counties.

Further, the development blueprint also omits key priority areas captured both in Sessional Paper 9 of 2012 and in an interview with the Director of Industrial Information and Research. There are 4 sub-sectors that are the focal point of current efforts: leather, cotton, Special Economic Zone and ease of doing business. The full list includes 21 areas: agro-processing and value addition; meat and meat products; milk and dairy products; fish and fishery products; leather and leather products; textiles and clothing; paper and paper products; ceramic products; glass products; recycling materials; packaging industry; petrochemicals; pharmaceutical products; electrical and electronics; mining and quarrying; iron and steel; machine tools and spares; automotive and auto parts; ; agro-machinery and farm implements; green energy; biotechnology; and nanotechnology (RoK, 2012:44). Of these, particular areas have been earmarked as priority sub-sectors based on comparative and competitive advantage, technological innovation, industrial linkages, and regional development. Agro-processing, textiles and clothing, and leather and leather goods are classified as
labour intensive, low technology areas. Iron and steel, machine tools and spares, agromachinery and farm implements, and the pharmaceutical industry are considered to be medium to high technology sectors. Finally, biotechnology and nanotechnology are referred to as advanced manufacturing sectors.

The First Medium Term Plan documents what was implemented between 2008 and 2012. The flagship projects were the development of industrial and manufacturing zones and the development of at least 5 SME parks and SEZs in key urban centres. Other projects were:

i. Product and market diversification and development programmes;

ii. Research development and commercialization programmes;

iii. Creation of an MSME R&D, risk and venture capital fund;

iv. Creation of a Business and Technology Incubation Programme to include an Incubation Fund; and 4 K (KEBS, KIRDI, KIPI, KNFJKA) MSE 2030 Project.

By the end of the First MTP, the Fourth and final Annual Progress Report (RoK, 2013: 66-68) following had been initiated, in progress or complete:

i. Development of SME parks: None had been completed. Land identification for development had been identified for the Eldoret and Nairobi SMEs.

ii. The 4 K 2030 Initiatives Project brought on board the Kenya Industrial Estates (KIE) and the Kenya National Trading Corporation (KN TC) as stakeholders involved in promotion of sub-contracting arrangements between MSMEs and large industries.
Other initiatives that are not reflected in the initial list but which were captured in the list by the Assistant Director at the Economic Pillar and which were implemented include:

i. Development of a strategy paper on the establishment of iron and steel industry and an MoU signed between the GoK and a South Korea investor;

ii. Training of engineers and technicians;

iii. The One-Village-One-Product Project;

iv. Promotion of investments in regions outside Nairobi;

v. Facilitation of sub-contracting between MSMEs and large enterprises;

vi. Promotion and development of women and youth MSMEs;

vii. Establishment of 120 Constituency Industrial Development Centres (CIDCs);

viii. Development of a verification and enforcement system in standards and labelling; and

ix. Sensitization and training of entrepreneurs, researchers and government agencies on development of manufacturing clusters. The MoIED continued discussions on the establishment of an industrial and technology park in Juja town on 32 acres of land allocated by the University.

There are legal and policy initiatives to institutionalise and anchor these initiatives and reforms in law. They include the cabinet memos, ministerial policies, Sessional Papers, Master Plans and Acts of Parliament. Among proposed legislation are the National Industrial Development Act, the Anti-Counterfeit Act (which is now the Kenya Anti-Counterfeit Agency), and the Consumer Protection Act. The Monopolies and Price Control Act of 1989 was to be fast-tracked to strengthen the institutional framework. By the Fourth Annual Progress Report, a draft Industrialization Policy
was developed. The Sub-Contracting Policy was redrawn. The Mining and Minerals Act of 2012 was enacted. Finally the Finance Institutions Bill was developed. The Master Plan for Kenya Industrial Development (MAPSKID) was developed and implemented, giving way to another masterplan. The National Incubation Policy and National Policy Agenda for Industrialization were also prepared and submitted to cabinet and NESC. Being developed too was the Industrial Development Fund to cater for the financing of industrial projects. Sessional Paper No. 9 of 2012 on the National Industrialization Policy Framework for Kenya 2012-2030 was also developed.

**Ministry of Education, Science and Technology**

STI is a fundamental foundation pillar in Kenya Vision 2030. The Ministry responsible for STI policy is the Ministry of Education, Science and Technology. The Ministry is headed by a Cabinet Secretary and assisted by 2 Principal Secretaries heading two State Departments: the State Department for Education, State Department for Science and Technology. The State Department for Science and Technology is responsible for STI policy and is constituted by 3 technical Directorates: Directorate of Higher Education (DHE), Directorate of Technical Education, DTE (which will now become the TIVET Authority) and the Directorate of Research Management and Development (DRMD). The DRMD is the focal point for the development of STI policy for the Kenya Vision 2030, playing a similar role as the Directorate of Manufacturing and Kenya Vision 2030, and both reporting to the Director-General, KV 2030, and to respective Principal Secretaries. It has 5 divisions: Industrial & Applied, Biomedical and Allied Sciences, Planning & Social Sciences, Environmental & Natural Resources; Agriculture & Allied Sciences. The NACOSTI
is an independent Commission providing advisory service to the Cabinet Secretary although it is engaged in turf wars with the DRMD on policy advisory and execution mandates. The science function works closely with the Commission for University Education (CUE) and the Higher Education Loans Board (HELB).

In the Kenya Vision 2030, the role of STI has received emphasis as a foundation pillar. The preamble notes that…:

_the Vision recognizes the role of Science, Technology and Innovation (STI) in a modern economy, in which new knowledge plays a central role in boosting wealth creation, social welfare and international competitiveness. Kenya intends to become a knowledge-led economy wherein the creation, adaptation and use of knowledge will be among the most crucial factors for rapid economic growth. Vision 2030 recognises that the process of the emergence of the knowledge economy is always associated with an increase in science-related and technology-related activities. STI has, therefore, become central to the new economic sectors that have given momentum to the upward growth of knowledge-based economies as a whole over the past few decades. STI will be mainstreamed in all sectors of the economy through carefully-targeted investments_

Among the strategies identified in the Kenya Vision 2030 to mainstream STI include strengthening technical capacities, improvement of the national pool of highly skilled human resources, intensification of innovation in priority sectors, and promoting STI awareness (RoK, 2007: 19-20). It is especially the third strategy that is of interest to this section. There are four key strategies to intensify innovation in priority areas:

i. Increased funding for basic and applied research at higher institutions of learning and for R&D in collaboration with industries;

ii. Co-ordination of research activities among the various institutions so as to ensure synergy and avoid duplication;
iii. Transformation of proven technical knowledge produced in industries and tertiary institutions, especially universities, into technologies and protected as IPRs;

iv. Identification and protection of indigenous technology;

v. Establishment of a system of national recognition to honour innovators as a way of encouraging innovation and scientific endeavours;

vi. Strengthening the STI performance management framework.

By the Fourth Annual Progress Report, the following was the status of STI’s performance:

i. *Strengthening ST&I capacities and capabilities:* National ST&I indicators survey done; mechanisms of establishing 1 Science and Technology Park reviewed.

ii. *Developing a pool of qualified STI personnel:* National study on existing Science, Engineering and Technology (SET) skills launched and continued; framework for increasing GER in universities and TIVET developed; curriculum review of SET courses initiated; TIVET curriculum finalized;

iii. *Intensification of innovations in priority sectors:* Kshs. 400 million awarded and disbursed to selected research institutions to promote intensification of innovations in selected sectors; strategic international research collaborations and partnerships established; establishment of an award scheme for outstanding scientists; review of existing collaborations with individual countries and regional blocks.
iv. *Raising awareness on Higher Education, Science, Technology and Innovation (HESTI)*: National scientific conference and exhibition held; regional robot contests for universities and technical institutions; regional TIVET fairs.

v. *Expanding access to equitable, quality, and relevant higher education and TIVET*: Construction of 13 new public TIVET institutions starts; construction of new laboratories and workshops in all TIVET institutions starts; expansion of private universities; award of charters to public university colleges to become fully-fledged universities.

vi. *Improving the quality and relevance of tertiary education and training*: Standard for development of TVET curriculum prepared.

There were also policy, legal and institutional reforms being undertaken in the STI foundation pillar. The following policy strategies were developed: STI Policy and Strategy, the Research and Development Strategy, the National TIVET Strategy and the National University Education Strategy. The following Acts of Parliament were enacted: STI Act of 2013, The Universities Act of 2012 and TIVET Act of 2013. The former National Council for Science and Technology (NCST) changed to NACOSTI as envisaged by the STI Act.

The STI Sector Plan 2008-2012 (RoK, 2008:10) presents STI sectoral challenges and proposes supportive technology platforms for key productive sectors. For manufacturing, the sectoral challenge is the development of technical capabilities and capabilities in manufacturing. The Sector Plan proposes the following STI interventions for the subsector:

i. Support R&D, technology transfer (through licensing, joint venture, etc) and design and development capacities and capabilities;
ii. Strengthen linkages for knowledge generation and use within industry, universities, research institutions and other knowledge intermediaries;

iii. Cost-saving production processes;

iv. Develop and support technology-based enterprises;

v. Support skills development and upgrading in manufacturing;

vi. Advise, source and support application of efficient state-of-the-art technology and environmentally friendly techniques;

vii. Integrate cleaner production techniques;

viii. Provide technology-based business incubation support services; and

ix. Assessment and characterization of materials requirements for various manufacturing sectors.

In an interview with the Assistant Director under the Economic Pillar in the Kenya Vision 2030 secretariat, the mainstreaming of STI in manufacturing is a key policy priority which is being pursued through the following:

i. Increasing the budgetary allocation to R&D to 2% of the GDP;

ii. Increasing the awareness and capacity for IPRs protection within MSMEs through the 5K initiative that brings together the Kenya Industrial Research and Development Institute (KIRDI), The Kenya Industrial Property Institute (KIPI), the Kenya Bureau of Standards (KEBS), the Kenya Industrial Estates (KIE), and the Kenya National Federation of Jua Kali Association;

iii. The Connect Kenya Conferences by the Kenya ICT Authority to showcase innovations and reward innovators; and

iv. Linking academia and researchers and industry through SME parks and in specific strategic sectors such as energy and ICT. Two university-based
Industrial and Technology Parks were already in the process of construction at the JKUAT and at Egerton. The objective is to facilitate research and technology transfer from the universities to the SMEs in these parks and later to the economy through smart manufacturing. Further, there is a partnership between the University of Nairobi and the Ministry of Energy to develop smart energy based on coal. Further, there was also partnership between the Ministry of Information and Technology, the Ministry of Education, Science and Technology, the University of Nairobi and JKUAT to develop tablets and laptops.

**Universities**

According to the Assistant Director, the Economic Pillar, the role of universities in these planning and implementation blueprints is infused within the flagship projects. For example, some SMEs are envisaged to actually set up within universities as university industrial and technology parks, such as the ones to be set up at Egerton and JKUAT. Universities will also be set up within the SEZs, such as Konza in which the first phase consists of setting up a university, and their influence in economic clusters as constituents of innovation clusters is also envisaged.

**Manufacturing Industry Associations**

The Kenya Association of Manufacturers (KAM), the Kenya Private Sector Alliance (KEPSA), the Kenya National Federation of Jua Kali Associations (KNFJKA) and Linking Academia With Industry (LIWA) were involved in the policymaking processes in the MoIED. The role of KEPSA and KAM will be highlighted briefly.
KEPSA is the national apex body of the private sector in Kenya. A membership organisation, it comprises of corporate organizations and business associations with 100,000 members in all sectors of the economy. It is the voice of the private sector and fulfils its mandate through advocacy, projects and partnerships both local and international. It seeks to influence public policy formulation and implementation through public-private dialogue platforms with the objective of institutionalising an enabling business environment. In these platforms, its advocacy role was significantly guided by the needs and priority issues of the business sector as contained in the National Business Agenda (NBA). In the second round of the NBA, the focus areas are: improving the regulatory environment, improving security, improving governance, infrastructure development, promotion and development of MSMEs, improving the productivity and competitiveness of the agricultural sector, natural resources, management, improving trade and investment, re-investing in human capital development, and promoting a culture of high performance. Their involvement in 2 areas is of significance to this study: promotion of MSMEs, human capital re-investment. In the former, the KEPSA seeks the effective implementation of the MSE Act by advocating the strengthening of MSME Associations, formalizing MSMEs, and improving their access to finance and training. The latter consists of supporting investment in TIVET and improving linkages between research, education and training institutions and the private sector.

The Kenya Association of Manufacturers is the representative organization for manufacturing value-add industries in Kenya. Established in 1959 as a private sector body, KAM has evolved into a dynamic, vibrant, credible and respected business association that unites industrialists and offers a common voice for businesses. KAM
provides an essential link for co-operation, dialogue and understanding with the Government by representing the views and concerns of its members to the relevant authorities. It is owned and managed by its members now numbering nearly 800 and has offices in Nairobi, Mombasa, Kisumu, Nakuru, Eldoret, Thika and Industrial Area. Its Vision is to be a world class business membership organization that effectively delivers services to members wherever they operate. The Mission is to promote competitive local manufacturing in a liberalized market. The Strategic Intent is to help build a globally competitive and inclusive Kenyan manufacturing industry. In its current engagements with the government under the NBA, its flagship project is the Industrial Business Agenda which it seeks to improve the competitiveness of Kenya as a location for manufacturing and increasing our trade with other African countries.

4.6.3 Co-Evolution of Institutional Spheres and Relationship to Knowledge-based Manufacturing in the First Medium Term Plan of Kenya Vision 2030

This section wraps up this section by asking the question: given the goal of creating a knowledge-based economy through the mainstreaming of STI as a foundation for socio-economic transformation in manufacturing, is there evidence of co-evolution in the national innovation system’s institutional spheres in manufacturing within the First Medium Term Plan roll-out phase of the Kenya Vision 2030 between 2008 and 2012? The analysis does not seek to establish causation or any rigorous correlational analysis because sectoral growth is a very complex phenomenon and adequate data to perform a semblance of growth accounting is lacking. What the analysis seeks to establish is whether the three key institutional spheres that form the emerging national
innovation system seem to be engaged in efforts that reinforce each other and thus implying co-evolution. The analysis compares the accomplishments in each institutional sphere within the life of the first MTP and then identifies synergies and discontinuities in what has been implemented. The final section presents key statistical indicators on the national innovation system within the First MTP (2008-2012).

Table 4.10 presents a comparative analysis of the achievements of the three key institutional players in the national innovation system in the manufacturing sector in Kenya in the First Medium Term Plan 2008-2012:

Table 4.10: Comparison of First MTP achievements in MoIED, MoEST and respondent universities

<table>
<thead>
<tr>
<th>FLAGSHIP PROJECTS IN MoIED IN MTP ONE</th>
<th>FLAGSHIP PROJECTS IN MoEST IN MTP ONE</th>
<th>STI ACTIVITIES IN MANUFACTURING AT JKUAT K.U.</th>
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<tr>
<td>Development of SME parks: Strengthening ST&amp;I capacities and Land identification for capabilities: National development had been ST&amp;I indicators survey identified for the Eldoret and done; mechanisms of Nairobi SMEs; Technology Park The 4 K 2030 Initiatives Project: This is constituted reviewed; of the KIRDI, KIPI, KNFJK, KEBS, KIE, KNITC as stakeholders National study on existing qualified STI personnel:</td>
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involved in promotion of sub-contracting arrangements between MSMEs and large industries; 

**Iron and Steel industry:** Development of a strategy paper on the establishment of iron and steel industry and an MoU signed between the GoK and a South Korea investor; 

**Manpower development:** Training of engineers and technicians; 

**The One-Village-One-Product Project;**

**Dispersing industrialization:** Promotion of investments in regions outside Nairobi; 

**Subcontracting:** Facilitation of sub-contracting between MSMEs and large enterprises; 

**Promotion and development of women and youth MSMEs;**

**Establishment of 120 Constituency Industrial Development Centres (CIDCs);**

**Development of a verification and enforcement system in Science, Technology**
standards and labelling: and Innovation
Clusters: Sensitization and training of entrepreneurs, researchers and government agencies on development of manufacturing clusters. (HESTI): National scientific conference and exhibition held; regional robot contests for universities and technical institutions; regional TIVET fairs.

Industrial and Technology Park: The MoIED continued discussions on the establishment of an industrial and technology park in Juja town on 32 acres of land allocated by the University

Expanding access to equitable, quality, and relevant higher education and TIVET: Construction of 13 new public TIVET institutions starts; construction of new laboratories and workshops in all TIVET institutions starts; expansion of private universities; award of charters to public university colleges to become fully-fledged universities.

Improving the quality and relevance of tertiary education and training: Standard for development of TVET curriculum prepared.
From the Table, it is evident that there are serious challenges in priority setting and execution in a co-ordinated manner. The following pertinent observations need to be made:

i. The priority lists for policy execution in the manufacturing sector as spelt out in the Kenya Vision 2030, the First MTP roll-out scheme for the MoIED, and the MoIED’s policy priorities are inconsistent. This inconsistency is emphasized in the additional details provided by the policymakers in the Kenya Vision 2030 secretariat and the MoIED;

ii. The STI needs for the manufacturing sector are clearly spelt out but these needs are not prioritised or mainstreamed in the manufacturing sector;

iii. The activities in which the universities are engaged in are not directly linked to the policy agenda of Kenya Visio 2030, the manufacturing sector, the STI sector, and the business sector as represented by KEPSA and KAM;

Thus, although there is an institutional, policy and legal framework in manufacturing, it is poorly co-ordinated. This is made even more pronounced by the delay in operationalizing a key agency envisaged in the STI Act of 2013, the Kenya National Innovation Agency (KENOIA) Part IV, Sections 28-31(817-820). Among its functions relevant for this discussion include:

i. institutionalise linkages between universities, research institutions, the private sector, the Government, and other actors in that system;

ii. cause the creation of science and innovation parks, institutes or schools or designate existing institutions as centres of excellence in priority sectors;

iii. develop and continuously benchmark national innovation standards based on international best practices;
iv. ensure the inclusion of STI in the country’s programs and policies at all levels;

v. implement the national innovation and commercialization policy;

vi. create synergies among different technological innovations and incubation initiatives for diffusion of technology in Kenya;

vii. identify strategic fields of innovation; and provide incubators for innovative ideas.

Thus, the absence of this co-ordinating institution sustains the fragmentation of initiatives, thus undermining the capacity of the country to hasten the development of a KBE and a knowledge-based manufacturing sector. Even more glaring is the failure of the NACOSTI to execute its first mandate as outlined in the STI Act, 2013 (Section 6:1a):

"...develop, in consultation with stakeholders, the priorities in scientific, technological and innovation activities in Kenya in relation to the economic and social policies of the Government, and the country’s international commitments."

The adoption of a Kenya Vision 2030 driven Performance Contracting approach as the basis for implementation of the Second Medium Term Plan, 2013-2017 promises to constitute a co-ordination mechanism that may help in the implementation of the rhetoric in policy documents.

Without implying causation, it would also be useful to present key manufacturing sector and STI statistics as a prelude to identifying any patterns in the First MTP period in the roll-out of Kenya Vision 2030. For the manufacturing sector, these key indices include: Manufacturing Value Added (MVA), Total Factor Productivity (TFP), contribution of the sector to GDP, and the share of technology-based products...
in manufacturing exports (TPME). For the STI sector, the key indices are GERD, GOVERD, BERD, and HERD to signal total R&D effort and GII. These statistics are presented in Table 4.11:

Table 4.11: Key Manufacturing sector and STI Statistics in the Kenya Vision 2030 First MTP

<table>
<thead>
<tr>
<th>YEAR</th>
<th>MANUFACTURING GDP%GROWTH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STATISTICS</td>
</tr>
<tr>
<td></td>
<td>MVA TFP %GDP TPME GERD BERD GOVERD HERD GII</td>
</tr>
<tr>
<td>2008</td>
<td>10.8</td>
</tr>
<tr>
<td>2009</td>
<td>9.9</td>
</tr>
<tr>
<td>2010</td>
<td>10.0 0.98 0.09 0.40 0.38</td>
</tr>
<tr>
<td>2011</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>8.9</td>
</tr>
</tbody>
</table>

The Table accentuates a key challenge in monitoring the development of a knowledge-based manufacturing economy, that is, limited data available. In more advanced countries with stronger data collection mechanisms, it is possible to study whether investments in R&D can be correlated with any changes in the GDP and value-addition. Thus, the absence of statistics to monitor key aspects of the emergence of a knowledge-based manufacturing sector complicates the ability to give a statistical picture of co-evolution.

The challenge of co-ordinating policy implementation has remained a challenge for the government and has been pointed out both in numerous policy documents

The Kenya Vision 2030 projects and programmes are multi-sectoral in nature. These programmes and projects also cut across agencies within government. However, effective implementation of the programmes and projects are hampered by non-holistic approach adopted by the government in implementing Kenya Vision 2030 programmes and projects. Instances of overlapping responsibilities and multiplicity of efforts among the agencies have frequently been experienced. This has proved to be challenging for some key projects due to lack of alignment to the Kenya Vision 2030 goals.

Oversight policy organs such as the National Economic and Social Council (NESC) and tools such as the National Integrated Monitoring and Evaluation System (NIMES), Central Planning and Project Monitoring Units (CPPMUs) and Ministerial Monitoring and Evaluation Committees (MMECs) in line ministries and Performance Contracting have been developed to streamline policy implementation but the challenge of policy planning and implementation remains.

4.7 Most Significant Challenges to Strengthening UIGLs in Manufacturing

This section reports findings on the challenges that confront all the respondent universities in advancing commercialization of knowledge and technology from the universities to the productive sector. In order to do so, the respondents were asked to report their opinions on the most significant challenges to strengthening linkages with the productive sector. The findings are presented in Figure 4.28:
Absence of a national policies and laws on IPR
Lack of established networks with the...
Industry secrecy stipulations preventing...
Limited capacity to market research outputs
Lack of commercialisable products
Inadequate research infrastructure (e.g) labs
Remote location of institution from industry...
Lack of recognition and incentives for staff
Lack of organizational structures
Lack of financial support for research
Lack of entrepreneurial skills and knowledge...
Apathy among academic staff

Figure 4.28: Responses on the most significant challenges to strengthening UIGLs

From the Figure, lack of financial support for research and other activities relevant to the productive sector, inadequate research infrastructure, and lack of established networks with the productive sector constituted the most significant challenges to strengthening engagement with the productive sector. The first two factors are also considerable constraints identified in the AAU-AUCC study (Ssebuwufu, Ludwick and Beland, 2011:33-34) and by Mwamadzingo (1996). This calls for concerted efforts to mobilise resources for research through public-private partnerships and contract and collaborative research. The lack of established networks with the productive sector is a challenge to universities to proactively strengthen their liaison structures and create robust entrepreneurial institutional cultures that attract vibrant links with the productive sector.
4.8 Interventions to enhance UIGLs for knowledge-based manufacturing in Kenya

In order to determine how interactions between universities and the productive sector in general could be strengthened, all respondent universities were asked to indicate the most important support services they would need from the government and other stakeholders. Figure 4.29 presents the findings:

![Figure 4.29: Responses on the most important support services needed to enhance institutional capacity to strengthen UIGLs](image)

Most respondent institutions identified funds to commercialize research outputs, training for middle and upper management in building relations especially with the productive sector, and opportunities to learn from institutions with a history of strong...
engagement with the productive sector as the 3 most important support services. This also constitutes the factors identified by the two case universities. These findings do not support those from the AAU-AUCC survey (Ssebuwufu, Ludwick and Beland 2011: 36-37) in which the three most important services needed were training for academic staff in entrepreneurial skills, development of an institutional SP with a focus on engagement with the productive sector, and support for establishing science parks and technology incubators.
CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents a summary of the study, a summary of key findings, conclusions and recommendations for policy as well as for further research.

5.1 Summary of the Study

The purpose of this study was to examine the contribution of universities in Kenya to the country’s industrialization agenda through university-industry-government linkages in the manufacturing sub-sector of the economy. The study was guided by the following research objectives:

i. Examine the extent to which the entrepreneurial concept exists in universities in Kenya with specific application in the manufacturing sector of the economy;

ii. Analyse the motivations for the creation of linkages between universities, the manufacturing industry, and the government in the context of knowledge-based industrialization;

iii. Examine the extent to which these linkages can contribute to the attainment of knowledge-based industrialization in Kenya;

iv. Identify the challenges facing the development of these linkages;

v. Suggest interventions to be instituted to enhance the potential of the linkages to promote the development of knowledge-based industrialization in Kenya.
The following research questions guided the study:

i. To what extent do University-Industry-Government Linkages (UIGLs) exist in the manufacturing industry in Kenya?

ii. To what extent are the UIGLs related to the development of a knowledge-based manufacturing sector in Kenya as envisioned in the Kenya Vision 2030?

iii. To what extent does co-evolution of institutional spheres in the identified UIGLs exist to support the emergence of knowledge-based manufacturing in Kenya?

iv. What are the challenges to strengthening UIGLs in the manufacturing sector of the Kenyan economy?

v. What support services are needed to enhance UIGLs for the development of knowledge-based manufacturing in Kenya?

An explanatory QUAN-qual mixed methods research design was adopted for the study. The target population consisted of 49 universities in Kenya, policymakers in ministries related to innovation policy in manufacturing, and private sector players in manufacturing. From this population, 17 universities were sampled using stratified sampling techniques. The policymakers and private sector respondents were purposively sampled. Questionnaires, interview schedules and a content analysis proforma were used to collect data for the study: the AAU-SHESHRA UIGLs questionnaire for the universities; the CIS AU-NEPAD Community Innovation Survey questionnaire for the innovating joint venture manufacturing firm; the National Development Policymaker Interview Schedule, the Kenya Vision 2030 Economic Pillar Policymaker Interview Schedule, the Industrialization and Enterprise Development Policymaker Interview, the STI Policymakers Interview Schedule, and the Manufacturing Stakeholders Interview Schedule; and the policy documents
analysis proforma. Quantitative data from the survey was analysed using version 2.0 of the SPSS and descriptive statistics in the form of frequencies generated. Qualitative data from the interviews was analysed through cross-case analysis. Qualitative, non-frequency content analysis of data obtained from policy documents was done to examine the extent of co-evolution in the linkage spheres and their connections to the aspirations of a knowledge-based manufacturing sector.

5.2 Summary of Key Findings

5.2.1 Extent to which the entrepreneurial university exists in Kenya

The core concern of this question was the extent to which universities in Kenya are becoming entrepreneurial by adopting third mission activities related to the transfer of knowledge, research findings and technology to the productive sector, particularly the manufacturing sector. In order to do so, respondents were asked to respond to questions on the following aspects: demographic dimensions such as location of the main campus, strategic focus of the university, postgraduate programmes, academic staff establishment and qualifications; institutional arrangements and interface structures; institutional policies; and the level and type of engagement with the productive sector in general and the manufacturing sector in particular.

With regard to the relevant demographic aspects with a bearing on institutional capacity to develop UIGLs, the study found the following:

i. Of the 17 respondents university, 8 were located in an urban area, 5 in a peri-urban area and 4 were in rural locations. A majority (9) have a comprehensive range of faculties and degree programmes, 4 have a focus on Science and Technology, 1 on Agriculture and Technology, 1 on Business, and 1 on Arts, Social Sciences and Humanities. All participating universities offered
postgraduate degrees. There were very high academic staff-student ratios that have accompanied the high enrolments. Less than a quarter of the academic staff in the majority of the respondent universities have doctoral degrees.

With regard to institutional arrangements and interface structures, the following are the key findings:

ii. All the respondent universities had a strategic plan available in their respective websites. The majority of the respondent universities’ strategic plans did refer to building linkages with the productive sector. A majority of respondent institutions have designated positions to encourage linkages with the productive sector. A majority of the respondent universities (13) also had a dedicated unit of office to promote and facilitate linkages with the productive sector. The majority of dedicated units/offices (5) are housed in the office of the DVC/Vice-Rector, which would be recognized as a division within senior university management. Networking and seeking out external partners’ and ‘contract negotiation’ are the key duties of the dedicated unit/office. Those aspects that are very instrumental for commercialization of knowledge do not feature prominently in the responsibilities list, that is ‘patenting and licensing’ (29.4 %), ‘seeking and managing venture capital’ (23.5 %), ‘development and management of spin-off companies’ (11.8 %), ‘managing technology incubators’ (41.2 %) and ‘managing science parks’ (23.5 %). An Industrial Relations expert is the most common specialist (41.25 %), followed by a Marketing specialist (35.3 %), and finally an IP/Contract expert. Among the 7 respondent universities, 2 felt they would require the combination of Entrepreneurial/ Marketing/ Industrial relations expertise, 2 felt they needed
just a Contract/ IP expert, I felt they needed an Entrepreneurial/Marketing expertise, 1 Industrial Relations/Marketing expertise, and 1 Technical and Engineering expertise. On the matter of institutional policies, 10 (58.8%) respondents indicated that there are policies but no mechanisms for monitoring time, while 6 (35.3%) respondents indicated that there were relevant policies and mechanisms for monitoring time. Almost all of the respondent universities (15) did have a policy on sharing and ownership of IP produced by staff. Concerning a framework for determining costing and pricing for contract research and technical consultancy services, 12 (70.6%) institutions had such a framework while 2 (11.8%) institutions did not. On guidelines as to how royalties and other profits from external collaborations were shared among the various actors, 9 (56.3%) respondent universities had a policy, while 3 (18.8%) did not. The bulk of these pecuniary benefits (56.3%) were used to support the institutional budget, followed by re-investment into collaborations (37.5%), and then payment as bonuses (18.8%). It would appear most institutions did not have a foundation (6.3%), and none remitted the money to the treasury. With regard to policy on conflict of interest, 9 (52.9%) institutions have such a policy while 4 (23.5%) institutions do not. Finally, with regard to environmental policies that promoted or required individuals engaging collaboration with the productive sector to take environmental considerations into account, 10 (66.7%) institutions reported that such a policy did exist, while 3 (20%) institutions reported that they did not have such a policy. As to whether respondent institutions had any mechanisms to monitor or evaluate the profitability of its collaborations with the productive sector, half of the
respondents reported having such a tool. A majority (8) of the respondent universities were part of a NIS and RIS compared to 4 which were not.

With regard to the extent and types of linkages with the productive sector in general and with the manufacturing sector in particular, the following are the key findings:

iii. The respondent institutions were most active in Agriculture and agribusiness, Environmental management, Biotechnology, Computer engineering, Energy, Food processing, and Water resources. They had less collaboration with manufacturing, pharmaceuticals, Electronics and Engineering, and Mining. In particular, only 5 old public universities had linkages with the manufacturing sector: Egerton, JKUAT, Kenyatta, Moi, and Nairobi.

iv. Of these, only two reported having UIGLs that had resulted in commercialised outcomes. These were Jomo Kenyatta University of Science and Technology through a joint-venture company, the JKUAT-NISSIN Foods, and Kenyatta University’s CBIIC from which 5 SMEs had been incubated successfully and had commercialized products.

5.2.2 UIGLs and the development of knowledge-based manufacturing in Kenya

On the question of whether the identified UIGLs had any connection to the emergence of knowledge-based manufacturing, the study related the outcomes of the UIGLs to the policy priorities as spelt out in the Kenya Vision 2030 and as implemented through the First Medium Term Plan (2008-2012). The study found out that although there was explicit mention of employment creation motives and the facilitation of the growth of MSMEs in the UIGLs as envisaged in the Kenya Vision, there was only tangential and later mention of contributing to the creation of a knowledge-based
manufacturing in the Kenyatta University’s CBIIC. In a more direct manner, the study compared the relationship between these commercialised innovations from the UIGLs and the priority areas in the MoIED’s priority manufacturing sectors. The study found that these products were not in the priority areas. However, they had the capacity to creating novel niche products as envisaged in the Kenya Vision 2030’s expectations for the manufacturing.

5.2.3 Co-evolution of institutional spheres in the UIGLs and emergence of knowledge-based manufacturing in Kenya

With regard to the question of whether there was co-evolution in the institutional spheres involved in the creation of knowledge-based manufacturing sector, the study found out that:

i. The priority lists for policy execution in the manufacturing sector as spelt out in the Kenya Vision 2030, the First MTP roll-out scheme for the MoIED, and the MoIED’s policy priorities are inconsistent. This inconsistency is emphasized in the additional details provided by the policymakers in the Kenya Vision 2030 secretariat and the MoIED;

ii. The STI needs for the manufacturing sector are clearly spelt out in the STI foundation pillar but these needs are not prioritised or mainstreamed in the manufacturing sector, nor are they evident in the research and commercialization agenda of universities;

iii. The activities in which the universities are engaged in are not directly linked to the policy agenda of Kenya Visio 2030, the manufacturing sector, the STI sector, and the business sector as represented by KEPSA and KAM;
5.2.4 **Challenges to strengthening UIGLs in Kenya**

The study found that lack of financial support for research and other activities relevant to the productive sector, inadequate research infrastructure, and lack of established networks with the productive sector constituted the most significant challenges to strengthening engagement with the productive sector.

5.2.5 **Interventions needed to strengthen UIGLs for knowledge-based manufacturing in Kenya**

Most respondent institutions identified funds to commercialize research outputs, training for middle and upper management in building relations especially with the productive sector, and opportunities to learn from institutions with a history of strong engagement with the productive sector as the 3 most important support services.

5.3 **Conclusions**

The study concludes that universities in Kenya are taking steps to link with the productive sector and government in general, but that the linkages that support the commercialisation of knowledge, research and technology in the manufacturing sector are very few in deed. This was attributed to limited expertise, experience and resources to strongly drive and entrench the needed platforms on the part of universities, uncoordinated policy implementation by relevant government agencies, and lack-lustre participation of the industry.

The implications are the aspiration to become a knowledge-based economy will be greatly hampered due to inadequate availability of platforms to facilitate commercialization of knowledge, research and technology from universities.
5.4 Recommendations for Policy

In light of the study’s findings and conclusion, the study recommends the following:

i. Universities need to invest more in the generation and commercialisation of knowledge as the primary mover of UIGLs, especially with close consultation with the national development needs and in line with the national research agenda.

ii. Universities need to invest in the intensification of knowledge and technology transfer continuum as the basis for establishment of robust, sustainable, commercialisation platforms;

iii. The government needs to develop a research agenda that is in tandem with the country’s development priorities and to structure legal, institutional and policy incentives that help build national and institutional capacity for the commercialization of knowledge and technology;

iv. The private sector and the manufacturing sector needs to partner more closely with the government and universities in the setting of the national development agenda, the identification of research priorities, and provision of support incentives that will help in the actualization of a knowledge-driven manufacturing sector in Kenya;

v. There is need for the development of a robust data collection and analysis mechanism at national, firm and institutional levels as a basis for evidence-based policy formulation, scenario building and monitoring and evaluation.
5.5 Recommendations for Further Study

i. Due to scope of the study, the researcher could not collect data on the relationship between commercialization of research and its impact on MFP. Since this lies at the heart of the relationship between university research and economic growth, a study on this is recommended.

ii. A study on UIGLs in other sectors of the economy could also be carried out.
REFERENCES


adjustment: Towards indigenizing the policy debate (pp.240-266). Nairobi: IPAR.


APPENDIXES

APPENDIX 1: LETTER OF INTRODUCTION TO RESPONDENTS

Department of Educational Management, 
Policy & Curriculum Studies 
Kenyatta University, 
P.O. BOX 43844 
Nairobi 00100 
KENYA 
Date:.................................

Dear Respondent,

I am a student at Kenyatta University undertaking a doctorate degree in the above-named department.

I am conducting a research project focussing on Kenya’s innovation system and its relationship to the country’s industrialisation. I am seeking to identify how each of the actors in Kenya’s system for innovation is currently configured to contribute to the growth of the manufacturing sector. The study holds the promise of aiding the development of a knowledge-based economy that will help realise our development ambitions as enshrined in Kenya Vision 2030.

You have been identified as one of the key actors in Kenya’s innovation system. I kindly request you to go through the questionnaire and provide answers to the questions to the best of your knowledge. You are assured that the information given is strictly for research purposes only and will be treated with utmost confidence. You are not required your name on the questionnaire.

I thank you for the co-operation.

Yours faithfully,

Onesmus M. Thuo
APPENDIX 2: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. ONESMUS MUROKI THUO
of KENYATTA UNIVERSITY, 4378-1002
MADARAKA-THIKA, has been permitted
to conduct research in All Counties

on the topic: THE ROLE OF
UNIVERSITIES IN KNOWLEDGE-BASED
INDUSTRIALISATION IN KENYA: A STUDY
OF
UNIVERSITY-INDUSTRY-GOVERNMENT
LINKAGES IN MANUFACTURING

for the period ending:
30th September, 2015

Permit No: NACOSTI/P/14/4388/2516
Date Of Issue: 18th August, 2014
Fee Received: Ksh 1,000

Applicant's
Signature

Secretary
National Commission for Science,
Technology & Innovation
APPENDIX 3: NACOSTI RESEARCH AUTHORIZATION

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349, 310571, 2219420
Fax: +254-20-318245, 318744
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

Ref. No.

NACOSTI/P/14/4388/2516

Onesmus Muroki Thuo
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on “The role of Universities in knowledge –based industrialization in Kenya: A study of University-Industry-Government Linkages in Manufacturing,” I am pleased to inform you that you have been authorized to undertake research in all Counties for a period ending 30th September, 2015.

You are advised to report to the Principal Secretary, Ministry of Industrialisation and Enterprise Development, the Chief Executive Officers of the selected Government Agencies, the County Commissioners and the County Directors of Education, all Counties before embarking on the research project.

On completion of the research, you are expected to submit two hard copies and one soft copy in pdf of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: SECRETARY/CEO

Copy to:

The Principal Secretary
Ministry of Industrialisation and Enterprise Development.
APPENDIX 4: KENYATTA UNIVERSITY IRST RESEARCH APPROVAL

KENYATTA UNIVERSITY
INSTITUTE FOR RESEARCH SCIENCE & TECHNOLOGY
Nigeria 3 Ext. 3840
Email: Director-crd@ku.ac.ke
INTERNAL MEMO

FROM: Director, Institute for Research, Science & Technology

TO: Mr. Onesmus M. Thuo
Department of Educational Management,
Planning & Curriculum Studies
Kenyatta University

REF: KU/IRST/DVC-ACD/1

DATE: 5th August, 2013

SUBJECT: REQUEST TO CONDUCT RESEARCH-MR. ONESMUS M. THUO

The above subject refers.

The Deputy Vice-Chancellor (Academic) has approved your application to conduct research as a student of Kenyatta University. Please ensure that you get appropriate government research permit, which is a requirement for all researchers in Kenya.

As advised by the Deputy Vice-Chancellor (Academic), you are required to submit a copy of your report/thesis to Kenyatta University Library. In addition, please submit your research abstract to the Institute containing the following:

- Your name
- Registration number
- School
- Year of Completion
- Title of the Project.

Thank you.

Prof. Wangari Mwai
Director: Institute for Research, Science & Technology

Deputy Vice-Chancellor (Academic)

Encl.
Appendix 5: Kenyatta University DVC-Academic Research

Approval Letter

Kenyatta University
Office of the Deputy Vice-Chancellor (Academic)

Tel: (+254-20) 8710901-19 Ext 57481
Fax: (+254-20) 8711380
Website: www.ku.ac.ke

Ref. KU/DVCACAD/IRT/VOL.2/155

2nd August, 2013

Mr. Onesmus M. Thuo
Department of Educational Management, Planning & Curriculum Studies
Kenyatta University

Dear Mr. Thuo,

REF: REQUEST TO CONDUCT RESEARCH – MR. ONESMUS M. THUO

The above subject refers.

Your request to carry out research on "The Role of Universities in Knowledge-based Industrialisation in Kenya: A Study of University-Industry-Government Linkages in Manufacturing" at Kenyatta University has been approved.

On completion of your research, you are expected to submit a hard and a soft copy of your research report/thesis to our University Library and the Institute for Research Science and Technology.

Please liaise with the Director, Institute for Research Science & Technology before commencing data collection for further guidance.

Thank you.

Prof. John Okumu
Deputy Vice-Chancellor (Academic)

c.c. Vice-Chancellor

JO/gmm

Kenyatta University ...ISO 9001:2008 Certified
JKU/2/003/072
18th September 2013

Onesmus Muroki Thuo
P.O. Box 43844 – 01002
NAIROBI

Dear Sir,

RE: REQUEST TO CONDUCT RESEARCH

Your letter on the above subject refers.

On behalf of Jomo Kenyatta University of Agriculture and Technology, I wish to inform you that the request has been granted on condition that the research findings shall be used solely for academic purposes. Kindly note that the title of your research is and should remain “The role of Universities in Knowledge-based Industrialization in Kenya: a Study of University-Industry-Government Linkages in Manufacturing.”

I wish you all the best as you embark on your research.

Yours faithfully,

PROF. ROMANUS ODHIAMBO
DEPUTY VICE CHANCELLOR ACADEMIC
Dear Eng. Kariuki

RE: REQUEST TO CONDUCT RESEARCH SURVEY BY MR. ONESMUS MUROKI THUO

The above named individual is a Ph.D candidate, registered with Kenyatta University had put in a formal request through the DVC, AA to conduct a research survey titled The role of Universities in knowledge-based industrialization in Kenya: A study of University-Industry-Government Linkages in manufacturing.

He was given approval by the DVC, AA's Office to carry out the exercise. The survey questionnaire and the approval letter are attached. I have perused through the survey questionnaire document and my opinion is that the Industrial Liaison Officer/Registrar AA are most suited as respondents.

Prof. M. Obanda
DIRECTOR, RESEARCH AND PRODUCTION

Copy to: DVC, AA
Registrar, AA
Onesmus M. Thuo
APPENDIX 8: AAU-AUCC BASELINE UNIVERSITIES SURVEY

QUESTIONNAIRE

LINKAGE BETWEEN UNIVERSITIES, INDUSTRY AND GOVERNMENT
SURVEY

Respondents are invited to complete the following sections:

<table>
<thead>
<tr>
<th>Section 1:</th>
<th>Contact information</th>
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<tbody>
<tr>
<td>Section 2:</td>
<td>Institutional Profile</td>
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<tr>
<td>Section 3:</td>
<td>Institutional Arrangements and Interface Structures</td>
</tr>
<tr>
<td>Section 4:</td>
<td>Institutional Policies</td>
</tr>
<tr>
<td>Section 5:</td>
<td>Level and Type of Engagement with the Productive Sector</td>
</tr>
<tr>
<td>Section 6:</td>
<td>Academic Staff and Students</td>
</tr>
<tr>
<td>Section 7:</td>
<td>Funding</td>
</tr>
<tr>
<td>Section 8:</td>
<td>Strengths, Opportunities, and Challenges</td>
</tr>
</tbody>
</table>

Notes and Instructions

- For the purpose of this survey, industry refers not only to the manufacturing sector but more generally to the entire productive sector, including agriculture, construction, computer programming, financial and banking institutions, and the hospitality industry, among others.

- This survey consists of 42 questions. Unless otherwise specified, check only one answer for each multiple choice question.

- If you are unable to complete a particular question, please proceed to the following question.

- There is a Glossary of Terms included at the end of the survey for your reference.

- Information obtained from this questionnaire is not intended to evaluate the performance of individual institutions. Only aggregated data will be presented publically.
SECTION 1: CONTACT INFORMATION

1. For follow-up purposes, please provide the following contact information:
   • Name of Institution: 
   • Country: 
   • Name of Respondent: 
   • Title/Position: 
   • Email address: 
   • Telephone (including country and area codes): 

SECTION 2: INSTITUTIONAL PROFILE

2. Is your institution considered a:
   □ Public institution
   □ Private, not-for-profit institution
   □ Private, for-profit institution
   □ Other (please specify)

3. What is the official language of instruction at your institution?
   □ Arabic
   □ English
   □ French
   □ Portuguese
   □ Other (please specify)

4. Where is your main campus located?
   □ urban area
   □ peri-urban area
   □ rural area

5. What is the primary strategic focus of your institution?
   □ Agriculture & Biotechnology
   □ Business
   □ Science & Technology
   □ Arts, Social Sciences & Humanities
   □ Comprehensive range of faculties and degree programs
6. Does your institution offer post-graduate degrees (e.g. master’s and/or doctorate degrees)?
☐ Yes
☐ No

7. Approximately how many students (full-time and part-time) are enrolled at your institution for this current academic year? Kindly check with the registrar’s office.
☐ 5,000 or less
☐ 5001-10,000
☐ 10,001-25,000
☐ More than 25,000
☐ Don't know

8. Approximately how many full-time and part-time academic staff are employed by your institution in the current academic year?
☐ 100 or less
☐ 101-500
☐ 501-1000
☐ More than 1000
☐ Don't know

9. Approximately what proportion of faculty hold a doctorate degree?
☐ 25% or less
☐ 26-50%
☐ 51-75%
☐ More than 75%
☐ Don't Know
SECTION 3: INSTITUTIONAL ARRANGEMENTS AND INTERFACE STRUCTURES

10. Does your strategic plan contain explicit reference to building linkages with the productive sector?
   □ Yes
   □ No
   □ Don't know
   □ There is no strategic plan

11. Are any of the following positions present at your institution?

<table>
<thead>
<tr>
<th>Positions Promoting Industry Linkages</th>
<th>Yes</th>
<th>No</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Deputy VC/ Pro-VC / Vice-Rector/ Vice-President in charge of industry linkages</td>
<td></td>
<td></td>
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<tr>
<td>ii. Provost or Dean/Director/Principal in charge of industry linkages</td>
<td></td>
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<tr>
<td>iii. Industry Liaison Officer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv. Committee on industry cooperation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>v. Representatives from industry/productive sector sit on the governing council/board</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi. Other individuals responsible for promoting linkages with the productive sector (please specify the title of the position)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. Does your institution have a dedicated unit or office responsible for promoting and facilitating linkages with the productive sector? (e.g. a consultancy or intellectual property unit, industry liaison office, etc...).
   □ Yes
   □ No (If you answered no, proceed to question 18)
   □ Don't know

13. Where is the unit/office located?
   □ Office of Vice Chancellor/President/Rector
   □ Office of the Deputy Vice-Chancellor/Vice-President/Vice-Rector
Another office located within the central administration. (Please specify)
Faculty/department (Please specify)
Semi-autonomous/external body
Other (please specify)
Don't know

14. What are the main responsibilities of the unit/office? (Mark all relevant answers):
Contract negotiation
Patenting and licensing
Seeking and managing venture capital
Development and management of spin-off companies
Networking and seeking out external partners
Managing technology incubators
Managing science parks
Managing cooperatives with local business entrepreneurs
Other (please specify)
None of the above
Don't know

15. What types of specialists does the unit/office employ? (Mark all relevant answers)
Contract/intellectual property (IP) expert
Entrepreneurial expert
Marketing specialist
Industrial relations expert
Other (please name)
None of the above
Don't know

16. What additional expertise is needed in the unit/office (e.g. contract/intellectual property (IP) expert, entrepreneurial-expert, marketing specialist, industrial relations expert...)?
17. What is the annual budget of the unit/office? (Please confirm with the finance officer)

- Less than US $5000
- US $5001-$10,000
- US $10,001-$25,000
- US$25,001-$50,000
- More than US $50,000
- Don't know

18. Is your institution part of a national or regional innovation system or strategy?

National Innovation system: “the set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.” (Metcalf, S. (1995). “The Economic Foundations of Technology Policy; Equilibrium and Evolutionary Perspectives” in P. Stoneman (ed.), Handbook of the Economics of Innovation and Technological change, Blackwell Publishers, Oxford (UK)

SECTION 4: INSTITUTIONAL POLICIES

19. Are there official policies and mechanisms for regulating the amount of time academic staff are expected to dedicate to academic activities versus private research and/or consultancy activities?

- There are no policies
- There are policies but no mechanisms for monitoring time
- There are relevant policies and mechanisms for monitoring time
- Don't know
20. Does your institution have a policy regarding conflict of interest (pecuniary) issues?

☐ Yes
☐ No
☐ Don’t know

**Conflict of interest**: describes an occurrence when an individual or organization’s involvement in one organization biases his/her ability to take impartial, independent actions in relation to another organization due to personal interest, particularly financial interest. For example, a conflict of interest may arise when a professor partners with industry for the commercialization of a product and simultaneously sits on the university board responsible for assessing the efficacy of that particular research.

21. What is your institution’s policy regarding the sharing and ownership of intellectual property (IP) produced by academic staff?

☐ The institution does not have an official policy
☐ The institution retains exclusive ownership of all intellectual property (IP) developed by academic staff
☐ Ownership of intellectual property (IP) is shared between the institution and academic staff
☐ Academic staff have exclusive ownership of intellectual property (IP) pertaining to their research
☐ Other types of arrangements (please specify)
☐ Don’t know

22. Does your institution have a framework to determine costing and pricing for contract research and technical consultancy services?

☐ Yes
☐ No
☐ Don’t know
23. Has your institution established guidelines outlining how royalties and other profits generated from collaborations with external actors are shared among staff, your institution, and third parties?
- Yes
- No
- Don't know

24. How are the profits, royalties, and other monies derived from university-industry collaborations used? (Check all relevant answers)
- As support to institutional budget
- Saved in an institutional foundation
- Paid out as bonuses
- Remitted to the government treasury
- Re-invested
- Other (please specify)

25. Does your institution have any mechanisms to monitor or evaluate the effectiveness and/or profitability of its collaborations with the productive sector? If yes, please briefly specify the mechanism used (e.g. feedback mechanism, external evaluation, etc...).

26. Does your institution have any environmental policies that promote or require individuals engaging in work for or with the productive sector to take environmental considerations into account?
- Yes
- No
- Don't know
SECTION 5: LEVEL AND TYPE OF ENGAGEMENT WITH THE PRODUCTIVE SECTOR

27. In which sectors has your institution had collaborative engagement with the private and/or productive sector in the last 5 years? Engagement may include contract or collaborative research, consultancy, student attachments, or other related activities. (Please check **multiple** answers irrelevant).

- Agriculture and Agribusiness
- Biotechnology
- Banking
- Business
- Computer engineering
- Electronics
- Engineering
- Energy sector
- Entertainment industry
- Environmental management
- Food processing
- Hospitality and tourism
- Health technology
- ICT, including software engineering
- Manufacturing in general
- Mining
- Pharmaceuticals
- Water resources
- Other (please name )
- None of the above

28. What industry-oriented activities or other engagements with the productive sector has your institution undertaken in the fast five years? (Please check **multiple** answers if relevant).

- Surveyed and evaluated the skill needs and capabilities of staff (e.g. business school, engineering, science, technology, etc...)
- Surveyed the skill needs of industry
- Identified investment opportunities and prepared feasibility studies
- Conducted short courses for industry personnel
- Conducted short courses for small-scale local entrepreneurs
- Organized seminars and workshops on industry-related issues
- Provided consultancy services to enterprises (e.g. developed business plans, quality control guidelines, etc...)
- Supported technology incubators
- Supported science parks
- Engaged in research and development of commercialisable prototypes
- Supported development-oriented technology transfer for local communities? (e.g. modification of agricultural tools, new varieties of crops, etc.,)
- Other (please specify)

29. Has your institution ever worked with, for, or in collaboration with any of the following organizations in the last 5 years? If yes, provide a one sentence description of the activity where possible.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Collaboration? Yes/No/Don't know Optional: 1 sentence description</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. International Organizations [e.g. United Nations Industrial Development Organization (UNIDO)]</td>
<td></td>
</tr>
<tr>
<td>ii. Science Research Councils (e.g. Centre for Scientific and Industrial Research, etc...)</td>
<td></td>
</tr>
<tr>
<td>iii. Manufacturing or Industry Associations</td>
<td></td>
</tr>
<tr>
<td>iv. Banking institutions or Chambers of Commerce</td>
<td></td>
</tr>
<tr>
<td>v. State/Crown Corporations</td>
<td></td>
</tr>
<tr>
<td>vi. Transnational/large national corporations (e.g. UNILEVER, HTN, etc...)</td>
<td></td>
</tr>
<tr>
<td>vii. Micro-enterprises/small-medium sized enterprises (SME) (e.g. transport associations, hospitality industries, cooperative societies etc...)</td>
<td></td>
</tr>
<tr>
<td>viii. Other groups in the productive sector (please specify)</td>
<td></td>
</tr>
</tbody>
</table>
30. Briefly give an example of a positive and/or negative experience that occurred as a result of collaboration with the productive sector?

**Positive Example:** may showcase mutually beneficial partnerships, ability to leverage internal or external resources for industry-related research, commercialization of prototypes, institutional revenue enhancement (e.g. royalties) etc...

**Negative Example:** may highlight failed collaborations, creation of unsustainable and unprofitable schemes, patent infringement, etc...

SECTION 6: ACADEMIC STAFF AND STUDENTS

31. What types of resources and/or incentives does your institution offer to help academic staff work more closely with the productive sector? (Please check multiple answers if relevant).

- [ ] Engage guest speakers to provide business and entrepreneurial advice
- [ ] Institutional arrangements to support sabbatical placements or other types of exchanges within the private sector
- [ ] Employ industry leaders through an entrepreneur-in-residence program
- [ ] Recognition awards for industry-related research and entrepreneurial activities
- [ ] Monetary bonuses for industry-related research and entrepreneurial activities
- [ ] Promotion based on industry-related research and entrepreneurial activities
- [ ] Access to special funds for industry-related research
- [ ] Access to seed grants and other types of funds for commercializing research outputs (e.g. prototypes)
- [ ] Other (please name )
- [ ] No resources specifically devoted to building entrepreneurial skills
- [ ] Don't know
32. List which departments/faculties/schools engage professionals from industry or the productive sector for the following purposes:

i. for curriculum development

ii. as full-time or part-time lecturers (e.g. adjunct / visiting professors)

iii. as guest lecturers

SECTION 7: FUNDING

33. Has your institution received financing from industry or other groups in the productive sector for any of the following purposes? (Please check multiple answers if relevant).

- Institutional budget support
- Industry-commissioned research and/or technology development
- Sponsorship of university chairs in relevant disciplines
- Graduate student research
- Student scholarships
- Academic excellence awards for students
- Investments in laboratories and equipment at your institution
- Seed grants
- Other (please list)
- None of the above.

34. Approximately how much revenue has your institution received over the last 5 years from consultancy services for the productive sector, commercialization of research, joint research, and other activities undertaken with the productive sector?

- No revenue received
☐ Less than US$10,000
☐ US $10,000-$50,000
☐ US$50,001-$100,000
☐ US$100,001-$500,000
☐ Greater than US $500,000
☐ Don't know

35. Have any of the following sectors provided funding to help improve your institution's capacity to engage with the productive sector? Tick all relevant answers.
☐ Economic communities (e.g. ECOWAS, UEMOA, SADC, EAC, COMESA, etc...)
☐ National government
☐ Local government
☐ Private-sector enterprises
☐ Development partners
☐ Other (please name)

36. What other tangible benefits has your institution received as an outcome of industry-oriented research and/or collaboration with the productive sector? (Please check multiple answers if relevant)
☐ Creation of spin-off/ start-up companies
☐ Ownership of licences or patents
☐ Access to industry laboratories and equipment
☐ Networking and access to industry partners
☐ Journal publications
☐ Other (please specify)

37. What intangible benefits (e.g. increased institutional prestige, improved job satisfaction among academic staff, etc...) has your institution received as an outcome of industry-oriented research and/or collaboration with the productive sector? Please briefly describe.
SECTION 8: STRENGTHS, OPPORTUNITIES, AND CHALLENGES

38. From the list below, tick the 4 factors which have played the most significant role in fostering linkages between your institution and the productive sector?

<table>
<thead>
<tr>
<th>Factors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Expressed support by board of governors/governing council</td>
<td></td>
</tr>
<tr>
<td>ii. Explicit promotion of productive sector linkages in the strategic plan, annual plan or other institutional priorities</td>
<td></td>
</tr>
<tr>
<td>iii. Senior leadership positions devoted to promoting productive sector linkages</td>
<td></td>
</tr>
<tr>
<td>iv. Existence of a central office to provide support and coordination</td>
<td></td>
</tr>
<tr>
<td>v. Hiring and promotion of faculty linked to industry-related research and/or entrepreneurial activities</td>
<td></td>
</tr>
<tr>
<td>vi. Presence of academics or professional staff with entrepreneurial experience</td>
<td></td>
</tr>
<tr>
<td>vii. Increased institutional prestige</td>
<td></td>
</tr>
<tr>
<td>viii. Increased personal prestige among academic staff</td>
<td></td>
</tr>
<tr>
<td>ix. Interest among academic staff</td>
<td></td>
</tr>
<tr>
<td>x. Supplementary revenue from non-traditional sources (e.g. licensing and commercialising intellectual property, such as patents and copyright)</td>
<td></td>
</tr>
<tr>
<td>xi. Revenue from consultancy services</td>
<td></td>
</tr>
<tr>
<td>xii. Support from other external agencies</td>
<td></td>
</tr>
<tr>
<td>xiii. Government funding</td>
<td></td>
</tr>
<tr>
<td>xiv. Government polices promoting linkages with the productive sector</td>
<td></td>
</tr>
<tr>
<td>xv. Private-sector demand</td>
<td></td>
</tr>
<tr>
<td>xvi. Response to criticisms that HEIs do not contribute sufficiently to national economic development</td>
<td></td>
</tr>
</tbody>
</table>

39. Please list any other key enabling factors which have helped promote and/or strengthen engagement with the productive sector.
40. From the list below, tick the **three factors** which represent the **most significant** challenges to strengthening engagement with the productive sector at your institution?

<table>
<thead>
<tr>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Apathy among academic staff</td>
</tr>
<tr>
<td>ii. Lack of entrepreneurial skills and knowledge among academic staff</td>
</tr>
<tr>
<td>iii. Lack of financial support for research and other activities relevant to the productive sector</td>
</tr>
<tr>
<td>iv. Lack of organizational structures, such as dedicated offices or posts</td>
</tr>
<tr>
<td>v. Lack of recognition and incentives for staff</td>
</tr>
<tr>
<td>vi. Remote location of institution from industry centres</td>
</tr>
<tr>
<td>vii. Inadequate research infrastructure (e.g. labs)</td>
</tr>
<tr>
<td>viii. Lack of commercialisable products</td>
</tr>
<tr>
<td>ix. Limited capacity to market research outputs</td>
</tr>
<tr>
<td>x. Industry secrecy stipulations which prevent or limit the sharing of intellectual property, including the right to publish results freely in academic journals</td>
</tr>
<tr>
<td>xi. Lack of established networks with the productive sector</td>
</tr>
<tr>
<td>xii. Absence of a national policies and laws on intellectual property right protection</td>
</tr>
</tbody>
</table>

Please list any other key barriers to strengthening engagement with the productive sector not mentioned above

41. To what extent is your institution satisfied with its current level of engagement with the productive sector?

- [ ] very satisfied
- [ ] somewhat satisfied
- [ ] neither satisfied nor dissatisfied
- [ ] somewhat dissatisfied
- [ ] very dissatisfied
- [ ] don't know
42. From the list below, **tick the 3 most important** support services needed from government and other stakeholders to enhance your institution's capacity to strengthen linkages with the productive sector.

**Type of Support Required**

| i. | Development of an institutional strategic plan with a focus on engagement with the productive sector |
| ii. | Development of institutional policies for governing ownership of intellectual property (IP) rights |
| iii. | Opportunities to learn from institutions with a history of strong engagement with the productive sector |
| iv. | Training for academic staff in entrepreneurship skills |
| v. | Training for middle and upper management in building external relations, especially with the productive sector |
| vi. | Conferences or other events to help higher education institutions network with African enterprises and key actors in the productive sector |
| vii. | Funds to commercialise research outputs |
| viii. | Support for establishing technology incubators and/or science parks |
| ix. | Development of curricula that promotes entrepreneurial skills |
| x. | Other (please specify) |

Add any additional comments here.

Thank you for taking the time to complete this questionnaire!
Glossary of Terms

Absorptive capacity: the ability of a firm to utilize knowledge and apply it for commercial ends.

Applied (strategic research): refers to research directed towards a practical application for the purpose of solving a particular problem. Applied research often has commercial aims.

Basic (Fundamental) research: refers to experimental or theoretical investigations conducted primarily for the advancement of scientific knowledge without regard to practical applications or commercial objectives.

Commissioned/Contract research: Contract research where the question is defined by an external organization, such as the government or industry.

Conflict of interest: describes an occurrence when an individual or organization's involvement in one organization biases his/her ability to take impartial, independent actions in relation to another organization due to personal interest, particularly financial interest. For example, a conflict of interest may arise when a professor partners with industry for the commercialization of a product and simultaneously sits on the university board responsible for assessing the "efficacy of that particular research.

Cooperative: an enterprise or organization that is jointly owned or managed by a group of individuals for their mutual benefit.

Higher Education Institution (HEI): is a tertiary education institution recognized by the corresponding national accreditation body and which requires students to have completed senior high school prior to admission.

Incubator: See Technology Incubator

Industry: The production of an economic good or service in any of the 4 sectors of the economy: primary sector (raw material extraction industry such as mining and farming); secondary sector (construction and manufacturing); tertiary sector (services and distribution of manufactured goods) and the quaternary sector (knowledge industry such as RSiD activities, computer programming and biochemistry).

Intellectual property (IP): refers to inventions, patents, trademarks, industrial designs, and copyrights.
National Innovation System: "the set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.\(^1\)

Patent: a document which grants the inventor exclusive rights to his/her invention for a fixed period of time.

Pecuniary: concerning money, including monetary rewards.

Productive sector: Refers to areas of the economy that produce a marketable output, such as agriculture and manufacturing.

Royalty: payment provided to a patent or copyright holder for the right to use their property. Science Park (technology park): an area of industrial development in close proximity to a centre for higher education set up to help promote collaborations between industry and educational institutes and foster commercialization of research and technology. Collaborations with science parks are often expected to encourage entrepreneurship among academics and generate income for the higher education. Unlike technology incubators, science parks typically do not offer business assistance services and tend to be large-scale in nature. Soft-financing: a loan provided at below market rates and may include other types of concessions such as a longer repayment period.

Spin-off Company: the formation of a new company or entity. A research spin-off company, for example, is a company created by members of a university for commercialization of research findings.

Start-up Company: refers to an enterprise in the earliest phase of business development which is focused on new product development and its commercialization. Start-up companies are often associated with the high-tech industry and represent high risk, high potential investments.

Venture capital, often given in exchange for equity in the company, is frequently sought as a way to finance the company in its earliest stages.

**Technology (business) Incubator**: A program that supports new business formation by providing a comprehensive range of business support services to entrepreneurs and start-up companies. Support provided to early-stage companies is designed to help these businesses survive in the marketplace once they graduate from the incubator program. Incubators are often used to strengthen cooperation between public and private actors.

**Technology Transfer**: is the process of sharing scientific and technological developments with other users to promote the practical application of this knowledge through the development of **new products**, processes, applications, and services. Universities, for example, may have a technology transfer office dedicated to identifying research with commercial value. **Venture capital**: financial capital provided to start-up companies, typically in the high-tech industry, as growth funding to allow these new companies to continue to develop their products. Investors often receive equity in the company in exchange for financing received.
APPENDIX 9: AU-NEPAD COMMUNITY INNOVATION SURVEY
QUESTIONNAIRE

PART 1: GENERAL INFORMATION ABOUT THE ENTERPRISE

Name of enterprise:
Physical Address:
Telephone:
Email:
Main economic activity:
Year of establishment:

Short description of your main economic activity

1. Is your enterprise part of a larger group?
   A group consists of two or more legally defined enterprises under common
   ownership. Each enterprise in the group may serve different markets, as with
   national or regional subsidiaries, or serve different product markets. The head
   office is also part of an enterprise group.
   Yes □ No □

2. In which country is the head office of your group located?
   If your enterprise is part of an enterprise group, please answer all further
   questions with respect to your enterprise in Kenya only. Do not include results for
   subsidiaries or parent enterprises outside Kenya
   (Specify if necessary and applicable but not compulsory)

3. In which geographic markets does your enterprise sell goods or services?
   Yes □ No □

   (Specify if necessary and applicable but not compulsory)
Kenya

Nairobi ☐ Central ☐ Coast ☐ Eastern ☐
North Eastern ☐ Nyanza ☐ Rift Valley ☐ Western ☐

Rest of Africa

Europe ☐ United States ☐ Asia ☐ Other countries ☐

4. What was your enterprise’s total number of employees in 2008 and 2011?

Annual average number of employees, both full-time and part-time. If not available, give the number of employees at the end of each year.

2008 ..................................................................................................................

2011 ..................................................................................................................

What was the number of employees in 2011 with a university degree?

..................................................................................................................

5. What was your enterprise’s approximate total turnover for 2008 and 2011?

2008 KSh. ...........................................................................................................

2011 KSh. ...........................................................................................................

PART 2: PRODUCT (GOODS OR SERVICES) INNOVATION

During the period under review (2008 to 2011), did your enterprise introduce

1. New or significantly improved goods.

Yes ☐ No ☐

Exclude the simple resale of new goods purchased from other enterprises and minor changes that only alter the appearance of the product.

2. New or significantly improved services.

Yes ☐ No ☐
If NO to both questions, please go to question 3.1.

By whom were these product (goods and services) innovations developed?

Select the single most appropriate option only

1. Mainly your enterprise itself  
2. Your enterprise together with other enterprises (independent enterprises plus other part of your enterprise group (such as subsidiaries, sister enterprises, head office, etc.) or institutions (universities, research institutes, non-profit, etc))  
3. Your enterprise by adapting or modifying goods or services originally developed by other enterprises or institutions  
4. Mainly other enterprises or institutions  

3. Did these innovations originate mainly in Kenya or abroad?

<table>
<thead>
<tr>
<th>Region</th>
<th>Yes</th>
<th>No</th>
<th>Do not know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest of Africa</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Europe</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>United States</td>
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<td></td>
</tr>
<tr>
<td>Asia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other countries</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

4. Were any of your goods and service innovations during the period under review (2008 to 2011) new to your market or new to your firm?

Yes  
No  

1. New to your market? Yes  
No  

*Your enterprise introduced a new or significantly improved good or service onto your market before your competitors (it may have already been available in other markets).*
2. Only new to your firm? Yes □ No □

*Your enterprise introduced a new or significantly improved good or service that was already available from your competitors in your market.*

3. Please estimate the total turnover in 2011 of goods and service innovations introduced during 2008 to 2011 that were: 2011 turnover distribution

1. New to your market (Ksh) ........................................................................................................

2. New to your firm (Ksh) ........................................................................................................

3. Unchanged or only marginally modified (Ksh) .....................................................................

4. Total turnover in 2011 ........................................................................................................

*Include the resale of new goods or services purchased from other enterprises.*

**PART 3: PROCESS INNOVATION**

*Exclude purely organisational innovations such as changes in firm structure or management practice impacting on the final product—these are covered in question 10.*

1. During the period under review (2008 to 2011), did your enterprise introduce any?

   1. New or significantly improved methods of Manufacturing or producing goods or services? Yes □ No □

   2. New or significantly improved logistics, delivery or distribution methods for your inputs, goods or service? Yes □ No □

   3. New or significantly improved supporting activities for your processes, such as maintenance and operating systems for purchasing, accounting or computing? Yes □ No □

If No to all questions, please go to section 4.
2. By whom were these process innovations developed? *Select the single most appropriate option only*

Mainly your enterprise by itself  Yes  □  No  □

1. Your enterprise together with other enterprises (independent enterprises plus other part of your enterprise group such as subsidiaries, sister enterprises, head office, etc.) or institutions (universities, research institutes, non-profit, etc)  
   Yes  □  No  □

2. Your enterprise together with other enterprises or institutions  
   Yes  □  No  □

3. Mainly other enterprises or institutions  
   Yes  □  No  □

3. Were any of your process innovations introduced during the period under review (2008 to 2011) new to your market?  
   Yes  □  No  □  Do not know  □

4. During the period under review (2008 to 2011) did your enterprise have any innovation activities to develop product or process innovations that were

1. Abandoned during the period under review (2008 to 2011) before completion  
   Yes  □  No  □

2. Still ongoing at the end of 2011  
   Yes  □  No  □

If your enterprise also had no product or process innovations or innovation activity during 2008 to 2010 (NO to ALL options in questions 2.1, 3.1, and 4.1), please go to question 8.2. Otherwise, please proceed to question 5.1.
PART 5: THE MOST IMPORTANT AND PERFORMED INNOVATION ACTIVITIES AND EXPENDITURES

1. During the period under review (2008 to 2011), did your enterprise engage in the following innovation activities?

A. Intramural or in-house Research and Experimental Development (R&D)

Creative work undertaken on a systematic basis within your enterprise to increase the stock of knowledge and its use to devise new and improved products and processes (including software development in-house that meets this requirement).

Yes ☐ No ☐

B. If yes, did your firm perform R&D during 2008 to 2011:

- Continuously? ☐ Occasionally? ☐

C. Extramural or outsourced R&D

Same activities as above, but purchased by your enterprise and performed by other companies (including other enterprises within your group) or by public or private research organisations.

1. Acquisition of machinery, equipment and hardware

Acquisition of advanced machinery, equipment and computer hardware to produce new or significantly improved products and processes.

Yes ☐ No ☐

2. Acquisition of software

Acquisition of software to produce new or significantly improved products and processes.

Yes ☐ No ☐
D. Acquisition of other external knowledge

*Purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other enterprises or organisations.*

Yes ☐ No ☐

E. Training

*Internal or external training for your personnel specifically for the development and/or introduction of new or significantly improved products and processes.*

Yes ☐ No ☐

F. Market introduction of innovations

*Activities for the market introduction of your new or significantly improved goods and services, including market research and launch advertising.*

Yes ☐ No ☐

G. Design

*Activities to design improve or change the shape or appearance of new or significantly improved goods or services*

Yes ☐ No ☐

H. Other activities

*Implementation of new or significantly improved products and process such as feasibility studies, testing, routine software development, tooling up, industrial*

Yes ☐ No ☐

2. Please estimate the amount of expenditure in 2011 only for the first four innovation activities mentioned in 5.1 (A to D).

Include personnel and related costs.
*Include labour costs, capital expenditures on buildings and equipment specifically for R&D.*

B. Acquisition of R&D.

C. Extramural or outsourced R&D.
*Acquisition of machinery, equipment and software.*

D. Exclude expenditures on equipment for R&D.
*Acquisition of other external knowledge.*

Total of these four innovation expenditure categories (A+B+C+D)

1. During the period under review (2008 to 2011), did your enterprise receive any public financial support for innovation activities from the following sources?
*Include financial support via tax credits or deductions, grants, subsidised loans, and loan guarantees. Exclude research and other innovation activities conducted entirely for the public sector under contract.*

2. Local Government (City Councils, Municipalities etc)
   Yes ☐ No ☐

3. Central/National government (Budgetary allocations)
   Yes ☐ No ☐

4. National funding agencies e.g. NCST
   Yes ☐ No ☐

5. Foreign government and/or other foreign public sources (e.g. European Commission, USAID, SIDA etc)
   Yes ☐ No ☐
PART 6: SOURCES OF INFORMATION AND CO-OPERATION FOR INNOVATION ACTIVITIES

1. During the period under review (2008 to 2011), how important to your enterprise’s innovation activities were each of the following information sources? Please identify information sources that provided information for new innovation activities/projects or contributed to the completion of existing innovation activities/projects.

Information sources
Degree of importance
Tick N/A’ if no information was obtained from a source.

<table>
<thead>
<tr>
<th>Sources</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>N/A</th>
</tr>
</thead>
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<tr>
<td><strong>Internal sources</strong></td>
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<tr>
<td>Sources within your enterprise or enterprise group</td>
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<tr>
<td><strong>Market resources</strong></td>
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<tr>
<td>1. Suppliers of equipment, materials, components or software</td>
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<tr>
<td>2. Clients or customers</td>
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<tr>
<td>3. Competitors or other enterprises in your sector</td>
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<tr>
<td>4. Consultants, commercial labs or private R&amp;D institutes</td>
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<tr>
<td><strong>Institutional sources</strong></td>
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<tr>
<td>1. Universities or other higher education institutions</td>
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<tr>
<td>2. Government or public research institutes</td>
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<tr>
<td><strong>Other sources</strong></td>
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<td></td>
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<tr>
<td>1. Conferences, trade fairs, exhibitions</td>
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<tr>
<td>2. Scientific journals and trade/technical publications</td>
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<tr>
<td>3. Professional and industry associations</td>
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</tbody>
</table>
2. During the period under review (2008 to 2011), did your enterprise co-operate on any of your innovation activities with other enterprises or institutions?  

*Innovation co-operation is active participation with other enterprises or non-commercial institutions on innovation activities. Both partners do not need to benefit commercially.*

Exclude pure contracting out of work with no active co-operation.

Yes ☐ No ☐

If no, please go to question 7.1

Indicate the type of co-operation partner and location.

Type of co-operation partner

Location

Tick all that apply.

Kenya

Rest of Africa

Europe

United States

Asia

Other countries

A. Other enterprises within your enterprise group

B. Suppliers of equipment, materials, components or software

C. Clients or customers

D. Competitors or other enterprises in your sector

E. Consultants, commercial labs or private R&D institutes

F. Universities or other higher education institutions

G. Government or public research institutes (e.g. Research councils)
3. Which type of co-operation partner was the most valuable for your enterprise's innovation activities?

*Give corresponding letter from 6.3. For example, clients or customers = “C”*

## PART 7: EFFECTS/OBJECTIVES OF INNOVATION DURING 2008–2011

1. How important or successful were each of the following types of outcomes for your products (goods or services) and process innovations introduced during the period under review (2008 to 2011)?

### Outcomes/Effects

**Level of success of outcomes**

Tick “No effect” if there were no innovation outcomes.

<table>
<thead>
<tr>
<th>Outcomes/Effects</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>No effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product oriented effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Increased range of goods or services</td>
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<td></td>
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<tr>
<td>2. Entered new markets</td>
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<tr>
<td>3. Increased market share</td>
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<tr>
<td>4. Improved quality of goods or services</td>
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<tr>
<td><strong>Process oriented effects</strong></td>
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<td></td>
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<tr>
<td>1. Improved flexibility of production or service provision</td>
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<tr>
<td>2. Increased capacity of production or service provision</td>
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<tr>
<td>3. Reduced production costs per unit of labour, materials, energy</td>
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<tr>
<td><strong>Other effects</strong></td>
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<tr>
<td>1. Reduced environmental impacts</td>
<td></td>
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<tr>
<td>2. Improved working conditions on health and safety</td>
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<tr>
<td>3. Met governmental regulatory requirements</td>
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</tbody>
</table>
2. How important were each of the following objectives for your products (goods or services) and process innovations introduced during the period under review (2008 to 2011)?

Objectives

Importance of objectives

Tick “Not relevant” if there were no innovation objectives.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Not relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase range of goods or services</td>
<td></td>
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<td></td>
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<tr>
<td>Replace outdated products or processes</td>
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<td></td>
</tr>
<tr>
<td>Enter new markets</td>
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<tr>
<td>Increase market share</td>
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<tr>
<td>Improve quality of goods or services</td>
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<tr>
<td>Improve flexibility for producing goods or services</td>
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<tr>
<td>Increase capacity for producing goods and services</td>
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<tr>
<td>Reduce production (labour, materials, energy) costs per unit output</td>
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<tr>
<td>Improve working conditions on health and safety</td>
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</table>

PART 8: FACTORS HAMPERING INNOVATION ACTIVITIES

During the period under review (2008 to 2011), were any of your innovation activities or projects:

1. Abandoned in the concept stage

   Yes □  No □
2. Abandoned after the activity or project was begun
   Yes ☐ No ☐

3. Seriously delayed
   Yes ☐ No ☐

QUESTIONS 8.2, 9 and 10 TO BE ANSWERED BY ALL ENTERPRISES:

During the period under review (2008 to 2011), how important were the following factors in hampering your innovation activities or projects or influencing a decision not to innovate?

Hampering factors

Degree of importance

Please also indicate particular factors that were not experienced.

<table>
<thead>
<tr>
<th>Hampering factors</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Factor not experienced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost factor</td>
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<tr>
<td>Lack of funds within your enterprise or group</td>
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<tr>
<td>Lack of finance from sources outside your enterprise</td>
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<tr>
<td>Innovation costs too high</td>
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<tr>
<td>Excessive perceived economic risks</td>
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<tr>
<td>Knowledge factors</td>
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<tr>
<td>Lack of qualified personnel</td>
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<tr>
<td>Lack of information on technology</td>
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<tr>
<td>Lack of information on markets</td>
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<tr>
<td>Difficulty in finding co-operation partners for innovation</td>
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<tr>
<td>Market factors</td>
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<tr>
<td>Market dominated by established enterprises</td>
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<tr>
<td>Uncertain demand for innovative goods or services</td>
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<td></td>
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<tr>
<td>Innovation is easy to imitate</td>
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<table>
<thead>
<tr>
<th>Other factors</th>
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<tbody>
<tr>
<td>Organisational rigidities within the enterprise</td>
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<tr>
<td>Insufficient flexibility of regulations or standards</td>
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<tr>
<td>Limitations of science and technology public policies</td>
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<table>
<thead>
<tr>
<th>No need to innovate</th>
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<tbody>
<tr>
<td>1. No need due to prior innovations</td>
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<tr>
<td>2. No need because of no demand for innovations</td>
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**PART 9: INTELLECTUAL PROPERTY RIGHTS**

During the period under review (2008 to 2011), did your enterprise:

1. Secure a patent in Kenya?
   - Yes \(\square\)  No \(\square\)

2. Apply for a patent outside Kenya?
   - Yes \(\square\)  No \(\square\)

3. Register an industrial design?
   - Yes \(\square\)  No \(\square\)
4. Register a trademark?
   Yes □ No □

5. Claim copyright?
   Yes □ No □

6. Grant a licence on any intellectual property rights resulting from innovation?
   Yes □ No □

PART 10: ORGANISATIONAL AND MARKETING INNOVATION

An organisational innovation refers to the implementation of a new organisational method in the firm’s business practices, workplace organisation or external relations in firm structure or management methods that are intended to improve your firm’s use of knowledge, the quality of your goods and services, or the efficiency of work flows.

A marketing innovation is the “Implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing” or sales methods to increase the appeal of your goods and services or to enter new markets.

1. During the period under review (2008 to 2011), did your enterprise introduce?
   Organisational innovations
   a. Business practices: New business practices for organising procedures (i.e. supply chain management, business re-engineering, knowledge management, lean production, quality management, etc) Exclude routine upgrades.
      Yes □ No □

   b. Work responsibilities and decision making: New methods of organising work responsibilities and decision making (i.e. first use of a new system of employee responsibilities, team work, decentralisation, integrating/de-integrating different departments or activities, education/training systems)
      Yes □ No □
c. External relations: New methods of organising external relations with other firms or public institutions (i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc)
   Yes □ No □

2. Marketing innovations
   c. Significant changes to the design or packaging of a good or service. Exclude routine/seasonal changes such as clothing fashions.
   Yes □ No □

   d. New or significantly changed sales or distribution methods, such as internet sales, franchising, direct sales or distribution licenses.
   Yes □ No □

3. If your enterprise introduced an organisational innovation during the period under review (2008 to 2011), how important were each of the following results or effects?

<table>
<thead>
<tr>
<th>Results</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>No results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased or maintained market share</td>
<td></td>
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<tr>
<td>Reduced time to respond to customer or supplier needs</td>
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<tr>
<td>Improved quality of your goods or services</td>
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<tr>
<td>Reduced costs per unit output</td>
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<tr>
<td>Improved employee satisfaction and/or reduced rates of employee turnover</td>
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</table>

PART 11: SPECIFIC INNOVATIONS BY YOUR ENTERPRISE

1. During the period under review (2008-2011), were any of your innovations:
   1. A first in Kenya?
      Yes □ No □ Don’t know □
2. A world first?

Yes ☐ No ☐ Don't know ☐

3. New or significant changes in your external relations with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting

Yes ☐ No ☐ Don't know ☐

If any of your answer to Question 11.1 was 'YES' then please give a short descriptions of these innovations (or attach separate pages or promotional brochures)

Please list other significant innovations in your enterprise in the last three years (or attach separate page or promotional brochures etc)

Thank you for your participation. It is sincerely appreciated.

Name of Respondent: .................................................................

Position: ..................................................................................

Telephone: ............................................................................

Email ......................................................................................

Address: ..............................................................................

Signature: ........................................Date: ..................................

Name of interviewer: ............................................................

Signature: ........................................Date: ..................................

Team Leader: ........................................................................

Signature: ........................................Date: ..................................
APPENDIX 10: MINISTRY OF NATIONAL DEVELOPMENT AND KENYA
VISION 2030 POLICY-MAKER INTERVIEW SCHEDULE

Q. In which ways is the Kenya Vision 2030’s priority in the creation of a knowledge-based economy being implemented?

Q. What are the mechanisms for gathering data on its attainment?

Q. How is the realisation of the objective of creating the knowledge-based economy being monitored?

Q. What challenges are experienced in the process of facilitating the creation of the knowledge-based economy?
APPENDIX 11: MINISTRY OF INDUSTRIALIZATION AND ENTERPRISE
DEVELOPMENT POLICYMAKER INTERVIEW SCHEDULE

1. Kindly tell me a little about yourself and what you do at MOIED

2. Industrialization in general and manufacturing in particular have always been viewed as a strategic sector in Kenya’s economic development agenda. Why is this so?

3. The development of a knowledge-based economy has been recently emphasized in development debates and is part of the values in KV2030. What are the implications for MOIED? In which specific ways is MOIED and affiliated SAGAs, other ministries and public agencies, the private sector and development partners?

4. How is the monitoring of development a knowledge-based manufacturing done? Are there specific indicators developed for that?

5. What challenges lie on the road to knowledge based manufacturing in Kenya?
Dear Sir,

I am a teaching member of staff at Kenyatta University. I am licensed to conduct a study on *The Role of Universities in Knowledge-based Industrialization in Kenya: A Study of University-Industry-Government Linkages in Manufacturing.*

I wish to seek for an appointment to meet you on information on the following:

1. How is a knowledge-based economy defined by the DRMD? Are there specific indicators developed as part of the conceptualization of the KBE and which can be used in monitoring its development in Kenya?

2. In what specific ways does the DRMD promote the development of a knowledge-based economy in general and of a knowledge-based manufacturing sector in particular? Are there any specific legal and policy instruments devised for that?

3. Which other actors does the DRMD partner with in the process of creating the knowledge-based economy in Kenya? Specifically, how does the DRMD work with the universities?

4. What challenges does the DRMD encounter in the course of facilitating the creation of the knowledge-based economy?

I trust that the outcomes of this study will be useful in supporting the DRMD on issues of R&D and innovation.

Yours faithfully,

O.M. Thuo
Dear Sir,

I am a teaching member of staff at Kenyatta University. I am licensed to conduct a study on *The Role of Universities in Knowledge-based Industrialization in Kenya: A Study of University-Industry-Government Linkages in Manufacturing*.

I wish to seek for an appointment to meet you on information on the following:

1. How is a knowledge-based economy defined by the NACOSTI? Are there specific indicators developed as part of the conceptualization of the KBE and which can be used in monitoring its development in Kenya?

2. In what specific ways does the NACOSTI promote the development of a knowledge-based economy in general and of a knowledge-based manufacturing sector in particular? Are there any specific legal and policy instruments devised for that?

3. Which other actors does the NACOSTI partner with in the process of creating the knowledge-based economy in Kenya? Specifically, how does the NACOSTI work with the universities?

4. What challenges does the NACOSTI encounter in the course of facilitating the creation of the knowledge-based economy?

I trust that the outcomes of this study will be useful in supporting the NACOSTI on issues of R&D and innovation.

Yours faithfully,

O.M. Thuo
Dear Sir,

I am a teaching member of staff at Kenyatta University. I am licensed to conduct a study on *The Role of Universities in Knowledge-based Industrialization in Kenya: A Study of University-Industry-Government Linkages in Manufacturing*.

I wish to seek for an appointment to meet you for information on the following:

1. How is a knowledge-based economy defined by the CUE? Are there specific indicators developed as part of the conceptualization of the KBE and which can be used in monitoring its development in Kenya?

2. In what specific ways does the CUE promote the development of a knowledge-based economy in general and of a knowledge-based manufacturing sector in particular? Are there any specific legal and policy instruments devised for that?

3. Which other actors does the CUE partner with in the process of creating the knowledge-based economy in Kenya? Specifically, how does the CUE work with the universities?

4. What challenges does the CUE encounter in the course of facilitating the creation of the knowledge-based economy?

I trust that the outcomes of this study will be useful in supporting the CUE on issues of R&D and innovation.

Yours faithfully,

O.M. Thuo
Dear Madam,

The research study I have been carrying out is anchored on the aspiration of the Government of Kenya (GoK) to create a knowledge-based manufacturing sector that will be an engine for rapid industrialization in Kenya (Kenya Vision 2030, 2007). On the basis of your understanding of Kenya’s development scene and of the manufacturing sector in particular, and from your international exposure, please share your thoughts on the following:

1. What is your understanding of a knowledge-based economy and knowledge-based manufacturing? What is the role of universities in the knowledge-based economy and knowledge-based manufacturing?

2. How is knowledge-based manufacturing done in countries that you have visited? Are there particular ones that have practices that you consider remarkable? Kindly share these practices. How does Kenya compare with such countries? What role do universities play in these contexts?

3. What does KAM do? In what way does that relate to GoK aspirations to develop a knowledge-based manufacturing sector? Do you work with universities in Kenya as KAM? If so, how?

I would be very grateful if you could kindly share your thoughts on these and any other related issues.

Warm regards.

Onesmus
APPENDIX 16: KENYA PRIVATE SECTOR ALLIANCE CEO INTERVIEW

SCHEDULE

THE ROLE OF UNIVERSITIES IN KNOWLEDGE-BASED MANUFACTURING IN KENYA: KENYA PRIVATE SECTOR ALLIANCE (KEPSA) CEO INTERVIEW

Dear Madam,

The research study I have been carrying out is anchored on the aspiration of the Government of Kenya (GoK) to create a knowledge-based manufacturing sector that will be an engine for rapid industrialization in Kenya (Kenya Vision 2030, 2007).

On the basis of your understanding of Kenya’s development scene and of the manufacturing sector in particular, and from your international exposure, please share your thoughts on the following:

1. What is your understanding of a knowledge-based economy and knowledge-based manufacturing? What is the role of universities in the knowledge-based economy and knowledge-based manufacturing?

2. How is knowledge-based manufacturing done in countries that you have visited? Are there particular ones that have practices that you consider remarkable? Kindly share these practices. How does Kenya compare with such countries? What role do universities play in these contexts?

3. What does KEPSA do? In what way does that relate to GoK aspirations to develop a knowledge-based manufacturing sector? Do you work with universities in Kenya as KEPSA If so, how?

I would be very grateful if you could kindly share your thoughts on these and any other related issues.

Warm regards.

Onesmus
APPENDIX 17: DIRECTOR, KENYATTA UNIVERSITY CBIIC INTERVIEW

SCHEDULE

Dear Sir,

I am conducting a study on 'the Role of Universities in Knowledge-based Industrialization in Kenya: A Study of University-Industry-Government Linkages in Manufacturing. The focus has been on the linkages as platforms for the commercialization of university knowledge outputs, especially research outputs in the manufacturing sub-sector of the economy.

Kenyatta University has created a platform for the commercialization of knowledge through the K.U. CBIIC. I wish to seek information on how the Innovation and Incubation Centre facilitates this.

In particular, I am interested in the following aspects:

1. What is your understanding of the University’s role in the realization of a knowledge-based economy in Kenya?

2. How has the K.U. structured itself to play this role? This could cover such areas as the emphasis in its Strategic Plan, the creation of designated offices and other structures, institutional policies specifically emphasizing innovation, funding, etc.

3. What are some of the outstanding outcomes of its efforts to play the role of contributing to the creation of a knowledge-based economy in general and specifically in manufacturing? Are there specific products that have been commercialized? What does this process involve—which actors are involved, what are their roles in the process?

4. What are the challenges in the road to commercialization of knowledge and technology?

5. What could be done and by who to improve the contribution of K.U. to commercialization of knowledge so as to contribute to the creation of a knowledge-based economy?

I look forward to learning from your extensive experience both as an eminent researcher in your own right, but also as a manager of the CBIIC in a renowned entrepreneurial university.

Warm regards.

Onesmus
Dear Prof.,

Thank you for taking time off your obviously very tight schedule and limited time here to see me.

I am conducting a research study whose title is *The Role of Universities in Knowledge-based Industrialization in Kenya-A Study of University-Industry-Government Linkages in Manufacturing*. I am now focusing on successful stories of commercialization of research findings, and that is how I learned about you.

The interview will concentrate on the following questions to guide the narration of your academic and entrepreneurial story;

- The origin of JKUAT-NISSIN Foods Ltd;
- The respective roles of you as the researcher and entrepreneur, the university's role, other partners, and the government.
- What and who is involved in the commercialization process, e.g. IPR issues, funding,
- The challenges on that journey, and the lessons learnt,
- What could be done to facilitate commercialization of research in Kenya.

I look forward to our meeting.

Warm regards,

Onesmus
APPENDIX 19: DIRECTOR OF RESEARCH AND PRODUCTION, JKUAT

INTERVIEW SCHEDULE

Dear Prof.,

As I had shared with you, I am wrapping up the study on The Role of Universities in Knowledge-based Industrialization in Kenya: A Study of University-Industry-Government Linkages in Manufacturing. The focus has been on the linkages as platforms for the commercialization of university knowledge outputs, especially research outputs in the manufacturing sub-sector of the economy.

I was struck by the level of innovation taking place at JKUAT and thought it would be a good idea to learn how commercialization of research takes place in the institution. I had the privilege of meeting Abraham Wahid, an alumni of JKUAT and currently a doctoral student in Germany and was impressed at how JKUAT has been instrumental in shaping him into an academic entrepreneur.

In particular, I am interested in the following aspects:

1. What is the JKUAT's understanding of its role in the realization of a knowledge-based economy in Kenya?
2. How has the JKUAT structured itself to play this role? This could cover such areas as the emphasis in its Strategic Plan, the creation of designated offices and other structures, institutional policies specifically emphasizing innovation, funding, etc.
3. What are some of the outstanding outcomes of its efforts to play the role of contributing to the creation of a knowledge-based economy in general and specifically in manufacturing? Are there specific products that have been commercialized? What does this process involve—which actors are involved, what are their roles in the process?
4. What are the challenges in the road to commercialization of knowledge and technology?
5. What could be done and by who to improve the contribution of the JKUAT to commercialization of knowledge so as to contribute to the creation of a knowledge-based economy?

I look forward to learning from your extensive experience both as an eminent researcher in your own right, but also as a manager of research in a renowned entrepreneurial university.

Warm regards,

Onesmus
APPENDIX 20: INSTITUTIONAL CO-EVOLUTION ANALYSIS

PROFORMA

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<th>MINISTRY</th>
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