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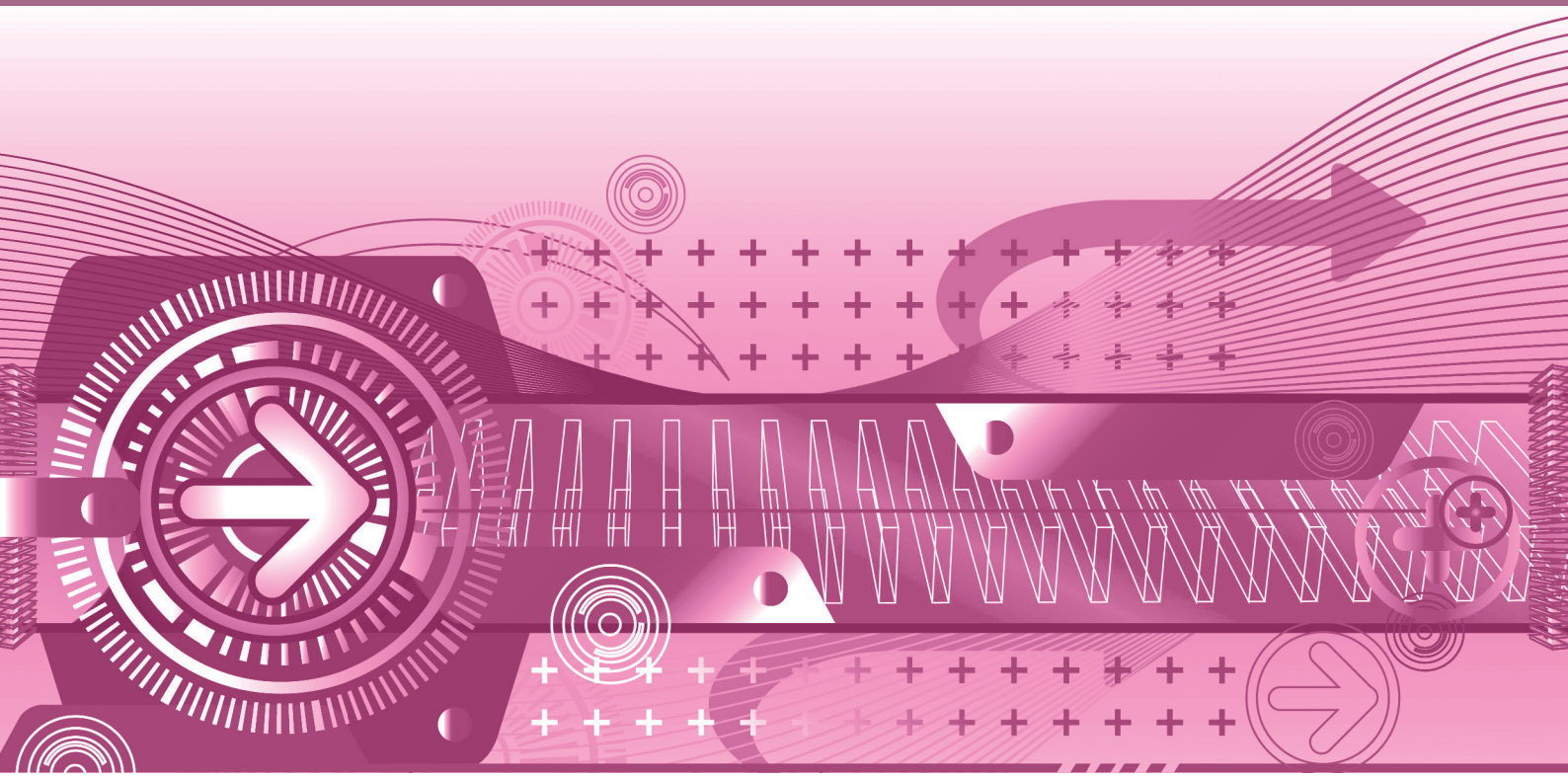

The Kenya National System of Innovation

Measurement, Analysis & Policy Recommendations

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

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March 2015

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1.0 Key Acronyms and Abbreviations

ARB	Arbitrageurs
BTS	Bartlett's Test of Sphericity
BEs	Business Enterprises
BWI	Bretton Woods Institutions
CEO	Chief Executive Officer
CAS	Complex Adaptive Systems
CTVE	Cumulative Total Variance Explained
DASI	Data Acquisition Survey Instrument
DISK	Data Information Statistics Knowledge
ECDC	Early Childhood Development and Education
ERS	Economic Recovery Strategy for Wealth and Employment Creation
EFA	Education for All
EMEs	Emerging Market Economies
FI	Financial Institution
FIs	Financial Institutions
FDI	Foreign Direct Investment
FDSE	Free Day Secondary Education
FPE	Free Primary Education
GSIS	Geo-Spatial Information Systems
GERD	Gross Expenditure on Research & Development
GNSI	Ghana National System of innovation
GOV	Government
GoK	Government of the Republic of Kenya
GVC	Government-Backed Venture Capital
GDERD	Gross Domestic Expenditure on Research and Development
GDP	Gross Domestic Product
IDA	International Development Association
HE	Higher Education
ICTA	ICT Authority
IDF	Industrial Development Fund
ICT	Information and Communications Technology
IIF	Institute of International Finance
IP	Intellectual Property
IPR	Intellectual Property Rights
ISIC	International Standard Industrial Classification
IRLS	Iteratively Reweighted Least Squares
KMO	Kaiser-Meyer-Olkin
KENIA	Kenya National Innovation Agency
KNSI	Kenya National System of Innovation
KNSIPU	Kenya National System of Innovation Policy Unit
KPIs	Key Performance Indicators
KBIs	Knowledge-Based Institutions

LPRs	Licensing, Patent and Royalty fees
MHTI	Medium- and High-Tech Industry
MSMIs	Micro, Small and Medium Industries
MDGs	Millennium Development Goals
MEST	Ministry of Education, Science and Technology
MoIED	Ministry of Industrialization and Enterprise Development
NACI	National Advisory Council on Innovation
NACSTI	National Commission on Science, Technology and Innovation
NRF	National Research Fund
NSI	National System of Innovation
NEPAD	New Economic Partnership for Africa's Development
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
ODA	Overseas Development Aid
PVC	Private Venture Capital
PPP	Public-Private Partnership
R&D	Research and Development
RIs	Research Institutes
STI	Science, Technology and Innovation
STEMIT	Science, Technology, Engineering, Mathematics and Information Technology
SETIRC	Science, Engineering, Technology, and Innovation Research Council
TIVET	Technical, Industrial, Vocational and Entrepreneurship Training
TVE	Total Variance Explained
UNIDO	United Nations Industrial Development Organization
UPE	Universal Primary Education
US-VHC	Unsuccessful – Very High Constraint
VHS-VLC	Very Highly Successful – Very Low Constraint
VHI-VLI	Very High Innovativeness – Very Low Innovativeness
VHS-NS	Very Highly Successful – Not Successful
VI-I	Very Important – Irrelevant
VI-VS	Very Important-Very Strong
VI-VW	Very Important-Very Weak
VP-VN	Very Positive – Very Negative
VS-VW	Very Strong – Very Weak
VS-VW	Very Strongly – Very Weakly
VS-VLC	Very Successful – Very Low Constraint
WIPO	World Intellectual Property Organization

2.0 Preface

by LI Yong

Director General
United Nations Industrial Development Organization

The key to sustainable economic growth in Kenya lies with the effective exploitation of innovation, knowledge production and technology transfer mechanisms, first and foremost in relation to industrial development. This coherent and effective policy approach represents the ability of an economy to enhance its competitiveness and economic growth, particularly in the wider context of the global knowledge-based economy. With increasing importance placed on knowledge as a key economic driver, greater and effective management of knowledge resources are requisite and particularly crucial is the systematic organisation of tacit knowledge and codified knowledge, or information codified in publications, patents and other media exchanged through formal as well as informal channels. The mechanisms for knowledge flows include joint industry research, public/private sector partnerships, technology diffusion and human capital mobility.

A National System of Innovation (NSI) represents the strength and quality of the systematically organised interactions and linkages between Government, Knowledge-Based Institutions (KBIs), Industry and Financial Arbitrageurs. Its main characteristics, as well as policies that shape them, are the critical determinants of efficiency and effectiveness in the creation and dissemination of knowledge, both tacit and codified, and the application of science, technology and innovation in the economy. The visualisation and understanding of these system dynamics enable policy makers to develop approaches for enhancing innovative performance in the knowledge-based economies of today.

UNIDO acknowledges the importance of evidence in deploying optimally policy instruments and targeting available resources (economic incentives and institutions) for the Government of the Republic of Kenya (GoK) to achieve competitive advantage. This is attained through the development of a well-functioning NSI, working as a driver for long-term, socio-economic development. In this development a key dimension is the extent to which inclusive and sustainable industrial development is envisaged in the policy orientation of the Government. Inclusive and sustainable industrial development – the main outcome of the UNIDO General Conference of 2013, articulated in the Lima Declaration – is the foundation for the kind of industrial development that will cohere advancing income levels with equity.

The mandate of UNIDO – as one of the Specialised Agencies of the United Nations system – to provide its Member States capacity-building and policy advisory services is manifest in this Report.

This report, The Kenya National System of Innovation – Measurement, Analysis and Policy Recommendations, maps and measures, as well as analyses, the challenges, potential and opportunities arising from the NSI within Kenya's socio-economic context. The Report is a source of policy insight for supporting the GoK to elaborate a coherent, evidence-based industrial policy that articulates the role of science, technology and innovation throughout the economy.

The chapters in this Report are the result of UNIDO's services in capacity-building, policy analysis and empirical research, on the Kenya National System of Innovation (KNSI). It aims to enhance the understanding of the role of the core Actors, their interactions and perspectives. This provides a strong basis for strategic planning, policies and management of policy actions, to achieve effectively national targets and goals.

3.0 Foreword

by Prof. Jacob Kaimenyi
Cabinet Secretary, Ministry of Education, Science and Technology
Republic of Kenya

The objective to propel Kenya to a globally competitive and prosperous nation has been addressed in several Government of Kenya (GoK) policy initiatives, and is particularly embodied in the strategy Vision 2030. Within these policy frameworks, embracing science, technology and innovation have become more prominent than ever before.

The Government of Kenya's intention is to move from a "factor driven" model of economic development to one that is knowledge-based and "innovation driven". However there are challenges that need to be addressed including a fragmented Science, Technology and Innovation (STI) sector which is not reaping the benefits of synergy and networking; poor linkages between the research base and industry; inadequate funding with over-reliance on external resources; and lack of advocacy for STI at high political and policy levels. This results generally in a low global competitiveness ranking.

However, Kenya is making progress towards overcoming these barriers through clear and targeted policy interventions. Our policy orientation is therefore to increase productivity through enhancing competitiveness, employment and equitable social and economic development. In order to drive industrial transformation, Kenya requires continuously enhanced modern skills and competences, and greater use of STI. The National System of Innovation (NSI) is vital in achieving this end.

With technical assistance from UNIDO, the policy report - Kenya National System of Innovation – Measurement, Analysis and Policy Recommendations, provides an analytical view of the relevant actors within the NSI, their inter-relational dynamics, and their individual dispositions with respect to barriers to innovation and innovativeness, and policy instruments.

The analysis is based on the KNSI survey conducted by the UNIDO in 2014. The value of this Report lies firstly in its representation of the mapped and measured KNSI in terms of the strengths and weaknesses of organisational actor linkages. Secondly, it provides a comprehensive set of policy recommendations. Thirdly, the methodology serves as a high-resolution longitudinal instrument to monitor, assess and evaluate policy implementation with respect to the KNSI. Fourthly, it facilitates the hard choices regarding policy decisions and trade-offs related to the role of STI in industrial policy. Fifthly, it permits a view of the direction innovation policy would need to take in order to complement Kenya's industrial policy.

In the context of Kenya's recent economic growth performance in attaining middle-income status, the survey results are encouraging due to the positive contribution of the Actors themselves and the findings and issues that emerge for policy considerations. Indeed, the main findings of the analysis indicate the following with respect to the KNSI:

- Connectivity between the core Actors of the KNSI is fragile;
- KNSI has an asymmetric distribution of Actor linkages;
- There are certain imbalances in the directionality of Actor relationships;
- Significant latent factor barriers to innovation are uncertainty avoidance, risk and unsophisticated markets, and skills capacity; and
- Extant policy instruments face limitations in overcoming the constraints of the barriers to innovation.

The strategic importance of this in-depth study is that it provides Kenya with a menu of policy recommendations (short, medium and long term) evidence-based and tailored to Kenya's unique situation. Kenya in undertaking such an in-depth study sets itself apart from its competitors and bolsters the central role of STI. It becomes clear that at this stage of development, Industry needs support that can be effectively delivered through a comprehensive strategy which requires all key Actors' interventions, namely: Research and Development (R&D) in STI promoted by Knowledge-Based Institutions, state incentives and infrastructure improvements provided by the Government, as well as financial intermediation by Arbitrageurs, and industry's efforts to enhance its innovation profile.

As the KNSI survey results suggest, the Government of Kenya has several possible strategies for encouraging adaptive and innovative performance to strengthen the linkages among the key Actors in the STI system. This aim resonates with the intentions stated by the Government, especially in its STI, industry, and education policies.

It is hoped that the findings, implications and recommendations will be sources not only for informed discussion of STI policy, but also the foundation for designing business plans and management actions for implementing STI policy in support of Kenya's Vision 2030.

4.0 Acknowledgements

The KNSI survey and Report would not have been possible without the close collaboration of key personnel from the GoK, Ministry of Education, Science and Technology (MEST), namely: Dr. George A. Ombakho, Director Research Management and Development; Ms. Cecilia Nzau, Senior Assistant Director Research; Mr. Richard Mavisi, Assistant Director Research from the State Department for Science and Technology. In addition to the above, the United Nations Industrial Development Organization (UNIDO), and other Ministries of the GoK, namely the Ministry of Industry.

Profound expressions of appreciation and special gratitude are extended to the Director-General of UNIDO, Mr. LI Yong; the Honourable Cabinet Secretary of Education, Science and Technology, Prof. Jacob Kaimenyi, for making generous resources available for the execution of the survey and actively participating in the project; and, to UNIDO for providing funding resources and supporting the project team. The then Principal Secretary of the Ministry of Education, Science and Technology, Prof. Crispus Kiamba for Initiating the project with UNIDO, and the current Principal Secretary of the Ministry of Education, Science and Technology, Prof. Coletta Suda, for continuing this support.

The KNSI survey, data analysis and results presented in this report, have been performed, analysed and authored by Mr. Frank L. Bartels – UNIDO Staff Member and Mr. Ritin Koria – UNIDO Consultant. Research support, analytical studies, documentation services, and textual analysis of secondary services were efficiently provided by the project team members whose collective efforts are very much appreciated.

UNIDO Research Associate, Ms. P. Wanjiku provided excellent research support in the field in Kenya for operationalising the survey and data acquisition. UNIDO Research Associates, Ms. Bianca Cravena and Ms. Michela Bello who ably assisted in data analysis and other analytical studies, and documentation services at UNIDO Head Quarters, Vienna. Mr. Lauren Brassaw is thanked for editorial work and Ms. Simone Carneiro for layout and design.

Special thanks are extended to the University of Nairobi for their logistical and technical support during the capacity building phase of the project. In particular, Prof. Lucy Irungu, Dr. Isaac Kipchirchir, Prof. Moses Manene, Dr. I. Mwaniki, Ms. Caroline Ogutu, Dr. Nelson Owuor and Mrs. Rosemary Omwadho.

Appreciation is also extended to the staff of the office of the then UNIDO Representative in Kenya, Mr. O. Altera, whose efficient administrative and logistical support made the project execution all the more effective. Special thanks go to the current UNIDO Representative in Kenya, Mr. Mpoko Bokanga, for his facilitating engagement with the Project.

MEST and UNIDO are also especially grateful to all the Respondents: Government policy-makers, Chief Executives of Business Enterprises, Leaders in Knowledge-Based Institutions, and Directors of Financial Institutions, Venture Capital and Knowledge Brokering firms, for participating in the survey.

5.0 Executive Summary

This report, The Kenya National System of Innovation – Measurement, Analysis and Policy Recommendations, surveys and depicts for the benefit of the Government of Kenya (GoK) policy-makers, the essential and systemic features of the landscape of innovation and innovativeness in Kenya. This is a positive first step towards a coherent policy delivery mechanism as well as a long-term policy monitoring and management capability for Kenya.

Although there are many serious significant challenges identified from the analysis, it should be understood that the policy analysis, policy implications arising from the analyses and the policy recommendation to address these implications together provide an unprecedented menu of evidence-based policy choices to address the challenges. With this approach the Government of Kenya has demonstrated its full appreciation and understanding of the limitations of the Oslo and Frascati approaches to measuring solely innovation in firms and research institutions, and looks towards a more comprehensive and holistic methodology to mapping and measuring the Kenya National System of Innovation (KNSI). This is not to say that the outputs of the Oslo and Frascati based approaches are not useful. However, the approach herein to mapping and measuring the KNSI adds value in a way that it underpins the assets depictions and findings of Frascati and Oslo approaches and therefore enables an accurate visualisation of the connectivity between the core Actors of the KNSI; the significant barriers to innovation and innovativeness; as well as the relative success of extant policies in overcoming the barriers. After all it is not a matter of the number of assets a country has with respect to innovation and innovativeness, rather it is a matter of how well they are connected coherently.

This report, The Kenya National System of Innovation – Measurement, Analysis and Policy Recommendations, in presenting the results of surveying and depicting, for the benefit of policy-makers, the essential and systemic characteristics of the landscape of innovation and innovativeness in Kenya represents a landmark in evidence-based policy-making in Kenya. It is the result of 18 months of project execution in concert with MEST and key stakeholders in Kenya, including the University of Nairobi. The analysis, implications and recommendations need to be viewed in the light of the generally unprecedented economic performance of Africa in general, and Kenya in particular, with its' frontier economy status, its soon-to-be a hydrocarbons producer and its projected GDP growth rates of around six to seven percent per annum through to 2015[1].

The analysis of GoK policy documents; mapping and measurement of the KNSI in terms of analysing; linkages between (and within) Actors; barriers to innovation; and success of policy instruments (in relation to barriers to innovation and factors of policy success) discloses the significant key policy analysis findings, major implications from the analysis, and recommendations that stem from the policy implications of analysis.

The gist of the report points firstly to the KNSI, in terms of the connectivity between the core Actors of the KNSI, as being fragile and characterised by the absence of significant strong inter-linkages. Secondly, the analysis portrays the KNSI as an asymmetric distribution of Actor linkages accompanied by low density relationships between the Actors. Thirdly, there are serious imbalances in the directionality of the extant relationships that are found to be significant. Fourthly, the significant latent factor barriers to innovation are dominated by uncertainty avoidance, risk and unsophisticated markets, and skills capacity. Fifthly, extant policy instruments are, in the main, unsuccessful in overcoming the very high constraints of the barriers to innovation.

Therefore the dynamics in, and properties of, the KNSI are measurably and highly significantly characterised by pulverulent, truncated, perforated and, in several critical instances, absent Actor linkages. This overall fragility is exacerbated by unacceptably high barriers to innovation and exceptionally serious constraints (organisationally as well as systemically) on innovation that throttle innovativeness in economic activity. Furthermore, the policy instruments at the disposal of the GoK are neither calibrated nor configured to overcome successfully the barriers to, and constraints

[1] IMF, 2014, Regional Economic Outlook: Sub-Saharan Africa, Table SA1, p.67.

on, innovation even though, according to the perspective of Government Respondents available policy instruments are very highly successful and the barriers to innovation are very low constraints – a position diametrically opposed by the perspective of ALL Respondents, KBI and Arbitrageur Respondents.

The overarching findings from the KNSI survey analyses are manifold in four dimensions characterised by overall low levels of organisational capital which constrains the KNSI in system-wide permutations of the assets and skills that in concert produce significant innovation and innovativeness based on the application of science, technology, engineering, mathematics and information technology in the economy. These dimensions, ultimately the targets of policy craft and applied resources, are; <<Excessive Risk>>; <<Maladjusted Markets>>; <<Exiguous Human Capital>>; and <<Regulatory Deficiencies>>.

The first dimension <<Excessive Risk>> is manifest as a combination of a number of high economic risks, and transformational and transactional costs. The second, <<Maladjusted Markets>>, is manifest as completely insufficient level and low quality of demand. This is such that the rate of growth of the quality of market demand is characterised by relative simplicity and therefore local manufacturing and services are not 'pulled' towards innovative behaviour and tend not to offer products of higher qualities and value. These constraints, in concert, thwart the adaptive response mechanisms of KNSI Actors.

The third dimension, <<Exiguous Human Capital>> is manifest in the rate, quantity and quality of skills formation which are not currently commensurate with an innovation driven economy (Hall and Mairesse, 2006; Goh, 2005). Fourthly, <<Regulatory Deficiencies>> are manifest as a composite of low resolution in regulation and high rigidity in institutional 'rules of the game'.

At the finer grain of scrutiny, the Report finds that on the one hand generally the very important links between Knowledge-Based Institutions and Business Enterprises are absent and on the other hand the crucial linkages between Research Institutions (the principle sources of ideation and invention) and the production system of Medium- and High-Technology Industry – the nexus that is responsible for creating innovation in the country - are largely absent. This detachment when coupled with the separation of the Government, Business Enterprises, Knowledge-Based Institutions from each other creates serious dysfunctions in the role of Research Institutions. Even though the traditional relationships between Knowledge-Based Institutions (Higher Education) with Government are found to be very strong, they result in very few externalities. This is because Research Institutions are isolated from Government and have weak linkages with Higher Education.

Regarding Actor linkages and the level of innovativeness in Business Enterprises, the Report finds significantly that all four Actors have extremely weak inter, intra-linkages and there are very low levels of Business Enterprises innovativeness. This renders the KNSI largely ineffective and inefficient. However, interestingly, this view is significantly opposed by Government Respondents who assess Actors inter, intra-linkages and levels of Business Enterprises innovativeness as very strong with very high levels of Business Enterprises innovativeness.

The Report finds that policy instruments are generally unfit in addressing <<Excessive Risk>>; <<Maladjusted Markets>>; <<Exiguous Human Capital>>; and <<Regulatory Deficiencies>> and specifically are neither successful in overcoming latent factor barriers to innovation nor geared to reduce individual variable barriers to innovation. As a result the KNSI is, to a large extent, both ineffective and inefficient.

The major implications of the Report's findings that there are very few externalities, if any, that emanate from the public goods of funding and supporting Research Institutions are exacerbated by the absent nexus of Research Institutions and the production system of Medium- and High-Technology Industry. The lack of positive externalities magnifies the dysfunctions of the absent relationships relevant to innovation in the national economy. The remoteness of Actors causes them to be relatively independent of the policy making process in terms of wielding influence in configuring and calibrating policy to industry needs on the one hand and, on the other hand, exploiting knowledge as well as intermediating the flows of technical know-how.

Furthermore, the isolation of the Actors in the KNSI means that, on the demand-side, while Business Enterprises have restricted access to external sources of ideation and invention, Knowledge-Based Institutions are also restricted, on the supply-side, in exploiting IPRs, through intermediation and commercialisation, in markets. This mismatch leads to inadequate market intelligence necessary for competitiveness and specifically to a misalignment of KBIs (HE/RI) research and development operations with the strategic research requirements of Medium- and High-Tech Industry. The KBI stocks of Data, Information, Statistics and Knowledge (DISK) remain occluded and flows of DISK within the KNSI are too slow. Significant barriers to innovation concentrated with poorly calibrated and inadequately configured policy instruments imply disharmonies and incompatibilities in the KNSI that have to be addressed economy- and system-wide, as well as at the specific level of each Actor.

Finally, the findings point to the absence of means for mapping and measuring of the KNSI for policy assessment, craft, monitoring and evaluation over the long-term.

The key recommendations of the Report coalesce into four thematic areas namely; institutional, policy, performance and technical. First, it is strongly recommended that the Ministry of Industrialization and Enterprise Development (MoIED) and the Ministry of Education, Science and Technology (MEST) should become superordinated as a Ministry of Innovation, Science, Technology and Industry (MISTI) and primary formulator and coordinator of all innovation and KNSI related policy and strategy. With the Ministry of Education as a separate but very closely coordinated ministry. The vehicle for operationalising this strategy should be a statutory inter-ministerial KNSI Policy Unit chaired by the respective two Ministers and reporting to Cabinet. In addition a Science, Engineering, Technology, and Innovation Research Council (SETIRC) should be created (that will incorporate the current national commission for science, technology and innovation) and chaired at the Vice-Presidential level to re-strategise the purpose and functioning of all national agencies with mandates that involve innovativeness. The SETIRC as an umbrella institution will impart coherence to the dynamics of the KNSI.

Secondly, in order to address barriers to innovation and innovativeness, extant instruments should be recalibrated and reconfigured towards performance-based funding, structures, terms and conditions, and measures. This will condition, over time, the robust enhancement of innovation and innovativeness in the strategic, operational and tactical behaviour of KNSI Actors.

Thirdly, incentives and support to KNSI Actors should be conditional on: engagement of Medium- and High-Tech Industry with Knowledge-Based Institutions and *vice versa*; triangulation between non-Government KNSI Actors with respect to human capital mobility, intermediation, and intellectual property rights in relation to Government contracts, tendering and public procurement terms and conditions. Such conditionalities will increase the density of inter, and intra-Actor bi-directional linkages and assist to reduce the wide asymmetries in the KNSI.

Fourthly, the Report recommends a significantly more robust emphasis (with the necessary political will and significant volumes of financial support) on science, technology, engineering, mathematics and information technology as well as on the use of standards setting to increase the level of sophistication of the supply-side and market-demand side and regulation to eliminate constraints in doing business. Additionally a programme of promising local companies in Medium- and High-Tech Industry identification and support programme should be initiated in the short-term outlook. These performance oriented recommendations, reinforced by 'fit-for-purpose' audit of the available policy mix and the adoption of the NSI methodology for longitudinal policy craft, monitoring, assessment and evaluation, will drive the KNSI towards markedly greater reliability and stability in delivering higher levels of innovation to the national economy.

The Report on the KNSI recognises the value of comprehensive survey instrumentation and the critical importance of mapping and measurement as the basis of evidence-based policy craft and management. The reapplication of the methodology of mapping and measuring the KNSI in two to three years' time to ascertain the effects of policy choices, implementation and resource application on the KNSI, and hence innovation and innovativeness in the Kenyan economy is strongly advised.

In putting forward the KNSI analysis, implications and recommendations, the sovereignty of the GoK is fully respected. The policy implications and recommendations would need to be considered holistically and in their entirety. Finally, the final selection of recommendations and the resources to be applied in implementing policy on innovation and innovativeness remains a matter of sovereign choice by, and priorities of, the GoK.

6.0 Introduction

The KNSI survey is contextualised by the GoK's new development blueprint, "the Kenya Vision 2030", which was launched on the 10th of June, 2008, by President Mwai Kibaki, on the back of the successful Economic Recovery Strategy for Wealth and Employment Creation (ERS).

The economic, social and political pillars of the Kenya Vision 2030 are anchored on foundations of: science, technology and innovation (STI); as well as macroeconomic stability; continuity in governance reforms; enhanced equity and wealth creation opportunities for the poor; infrastructure; energy; land reform; human resources development; security; and public sector reforms.

This report is crafted to generate advantages in policy-making for the GoK with regard to innovativeness and innovation in the setting of the Kenyan national economy. Consequently, it is necessarily analytically intense and draws attention to the statically significant areas of strengths, weakness and fragility, as well as points of vulnerability and liability in the KNSI. This attention is expressed without value judgment, in full respect of the sovereignty of the GoK.

The primary purpose is to inform, with evidence, the national debate on innovation and innovativeness in the economy. Secondly, to better enable the GoK to consider strategic, operational and tactical policy choices. Thirdly, to facilitate better deployment of available resources in a prioritised and sequential manner, either to concentrate on reinforcing strengths and/or overcoming weaknesses in managing the relationships and assets of the core Actors of the KNSI.

Given the complexity and emergent characteristics of the KNSI, the report achieves this purpose by: (i) Providing a statistically significant set of tools, resources and metrics with which policy management can be mapped and measured through evidence-based data and analysis; (ii) Explaining the institutional and structural challenges faced in the policy management of the KNSI; (iii) Setting out key ideas, insights and examples of research and evidence from the survey; and, (iv) Delineating key principles for GoK policy-makers and the supporting policy community in Kenya. This is summarised as analysis, policy implications and policy recommendations.

In the management of, and implementation of policies for, the KNSI, policy-makers confront four major challenges: (i) The need to better comprehend the increasing pressures of decision-making; (ii) The dynamic tension between evidence, heuristics, practice and theoretical considerations; (iii) The paucity of data availability; and, (iv) The need for evidence-based pragmatic approaches that provide insights for decision-making.

This report portrays therefore, for policy management, the patterns and dynamics that characterise the KNSI, the relations of the core Actors (and their collective behaviour), as well as the interconnectedness of the structural elements of the KNSI. In digesting the report, policy-makers need to take into account the following key ideas: (i) The KNSI is characterised by a complex system of elements that are differentially interdependent, interconnected by multiple feedback mechanisms, and that system-wide behaviour emerges from accumulated interactions among the Actors and their assets; (ii) In complex systems (Allen, 2000), processes of change are highly sensitive to conditions and can shift dramatically with non-linear tipping points (points of policy leverage); (iii) As a complex (ultimately human) system, the KNSI is operated by 'adaptive agents' that act to maximise their interests and managerial utility, who network, react to and influence other Actors in the system, respectively. Enhancing the positive and co-reinforcing adaptive response capacities and capabilities of these networks through policy levers is essential to strengthening resilience, innovativeness and innovation.

The Report is based on empirical, data-driven statistically significant analysis to provide rigorous evidence-based insights. The following eight principles guide the policy analysis, implications and recommendations: (i) One cannot manage what is not measured and what gets measured gets done; (ii) Understanding the systemic nature of the KNSI; (iii) Involving those Actors that matter the most in decisions that are crucial to the effectiveness and efficiency of the KNSI; (iv) Avoiding 'one size-fits-all strategies' and embracing appropriately calibrated and configured multiple policy instruments; (v) Establishing real-time longitudinal analysis and learning as key to operational effectiveness;

(vi) Openness to adaptation of effort to local conditions; (vii) Framing the policy management of the KNSI as a dynamic network involving a multilateral system of Actors; and, (viii) Uncompromising willingness to make difficult 'trade-offs' in the context of limited resources. With these principles, a more innovative, relevant and appropriate approach to the policy management of the KNSI is possible.

6.1 Kenya National System of Innovation (KNSI) Survey Project Provenance

The KNSI Survey Project emerges from the GoK recognising the need for a more coherent approach to policy with respect to innovation within the national economy, particularly within the context of their overarching development strategy, Vision 2030, which:

"recognises the role of science, technology and innovation (STI) in a modern economy, in which new knowledge plays a central role is [*sic*] in wealth creation, social welfare and international competitiveness. There are four elements that allow effective exploitation of knowledge: (a) an economic and institutional regime that provides incentives for the efficient use of the existing knowledge, the creation of new knowledge, and the flourishing of entrepreneurship; (b) an educated and skilled population that can create, share and use knowledge well; (c) a dynamic information and communication infrastructure that can facilitate processing, communication, dissemination; and finally, (d) an effective innovation system (i.e. a network of research centres, universities, think tanks, private enterprises and community groups) that can tap into the growing stock of global knowledge, assimilate and adapt it to local needs, while creating new knowledge and technologies as appropriate" (Vision 2030, pg.20).

The current report is mandated by the request of the 9th of May, 2012, by the then Ministry of Higher Education Science and Technology of the GoK to UNIDO for Technical Cooperation assistance to carry out a mapping and measuring of the KNSI.

6.2 What Has Been Done

The KNSI Survey has been executed in the light of the fact that a holistic view of the NSI is indispensable to the efficacious execution of policy on innovation and innovativeness in the economy.

The Data Acquisition Survey Instrument (DASI) for the KNSI Survey was created using an iterative multi-step process. The first steps involved a survey of NSI literature (as well as a trawl of all innovation surveys since 2000) in 2007 by the UNIDO Statistical Research and Regional Analysis Unit. From this initial work, 300 comprehensive variables were extracted, which were then further reduced to 138 variables[2] (Bartels, *et al*., 2009). Using this extraction as a foundation, an initial perceptions-based survey instrument of NSI was created. In order to measure Actor perceptions and enable Respondents to express both the direction and strength of their opinion (Garland, 1991; Clason and Dormody, 1994), a five-point Likert scale was used. There is strong empirical evidence that supports the treatment of ordinal variables as conforming to interval scales (Labovitz 1967, 1970, 1971). The survey was then refined through a process of peer review [3]. This first version of the DASI is herein referred to as DASI-V1.

The DASI-V1 was then reverse translated into French and Spanish for the sake of accuracy and embedded into an electronic medium (Lime Survey) so as to create a web-based electronic questionnaire. In an effort to reduce measurement error and maximise validity, reliability and reproducibility (Karlen *et al*., 2010), questions were kept concise and definitions provided in help boxes where necessary. The details and choice of medium will be explained in greater detail later in this chapter.

The electronic DASI-V1 was then pilot launched in seven Emerging Market Economies (EMEs), namely, Egypt, Morocco, Chile, Peru, Malaysia, Thailand and the Ukraine. The selection of these countries was made on the basis of the Survey of Surveys of Innovation[4], which looked at innovation surveys conducted in EMEs as classified by the Institute of International Finance (IIF). Egypt, Morocco, Chile, Peru, Malaysia, Thailand and the Ukraine, were chosen because either no survey had been conducted, or one had not been conducted for a long time.

The DASI-V2 was then launched to map and measure the Ghana NSI in 2012, in response a request from the Ghanaian Ministry of Trade and Industry. The preliminary results of mapping and measuring the Ghana NSI using the novel quadrilateral approach were presented at various Technical Meetings which lead to a request from the Ministry of Education Science and Technology of the GoK, in May, 2012.

The following Figure 6.1 – Methodological Framework for KNSI Survey – illustrates the logic of the methodology with respect to the KNSI Survey.

The methodology uses an innovative remote DASI which has been operationalised and tested "in-house" and in African countries (The Manu River Union countries, and Morocco and Egypt). The approach consists of the following operational methodology (See Figure 6.2) where numerous steps are taken to ensure validity, reproducibility and maximal response rate (Karlen *et al*., 2010).

[2] Through this comprehensive review of literature the objective is to achieve a high level of internal and construct validity.

[3] In the process, the questionnaire was sent to Prof. J. Howells at the Centre for Research on Innovation and Competition (CRIC), U.K. and Prof. S. Mani at the Centre for Development Studies, India, for peer review, additional suggestions and inputs. The process of peer review is maintained with Prof. Henry Etzkowitz reviewing the methodological approach in 2014.

[4] The Survey of Surveys of Innovation was conducted by Ms. Simone Carneiro, UNIDO consultant in 2007.

Figure 6.1 – Methodological Framework for KNSI Survey.

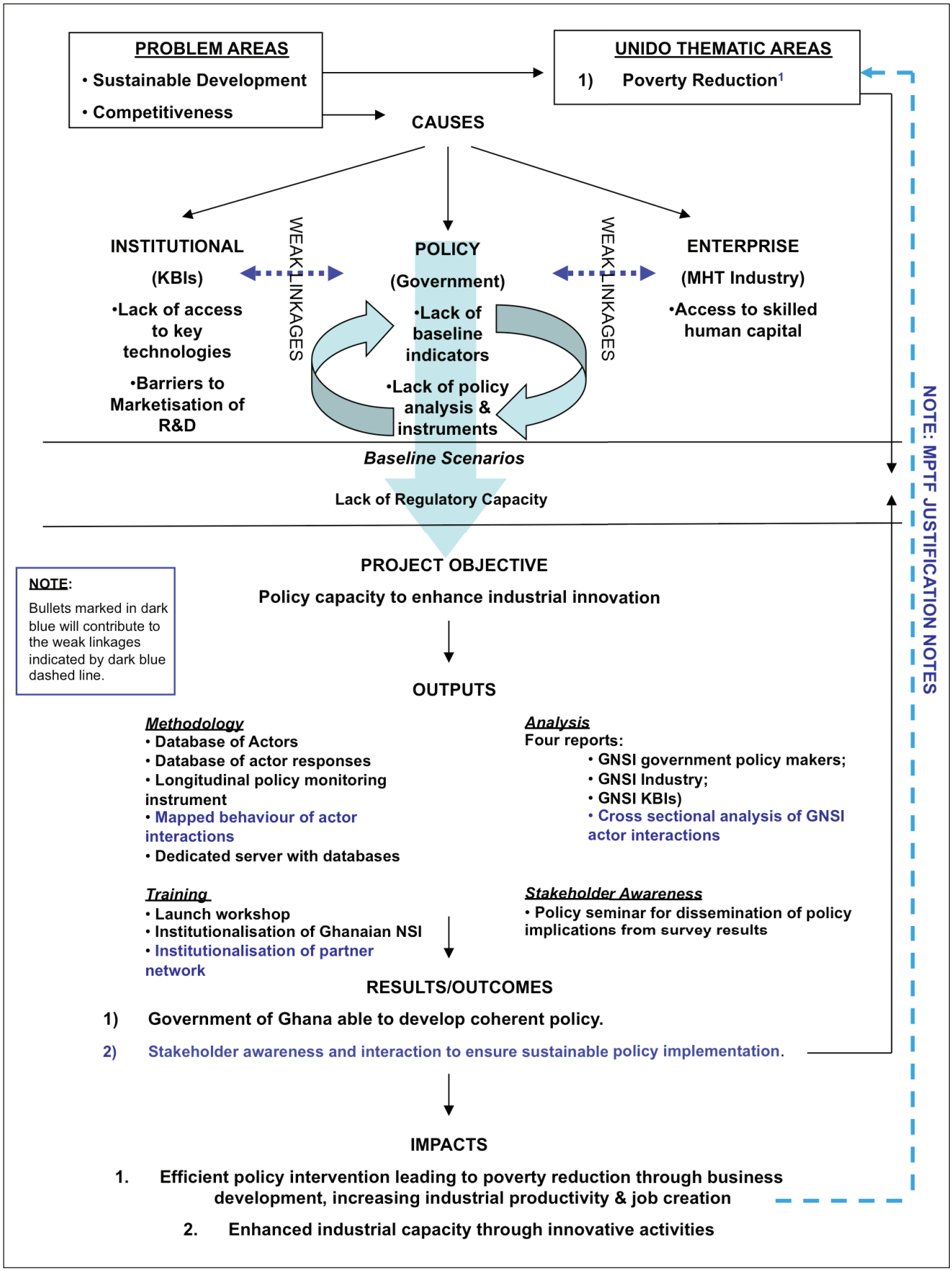
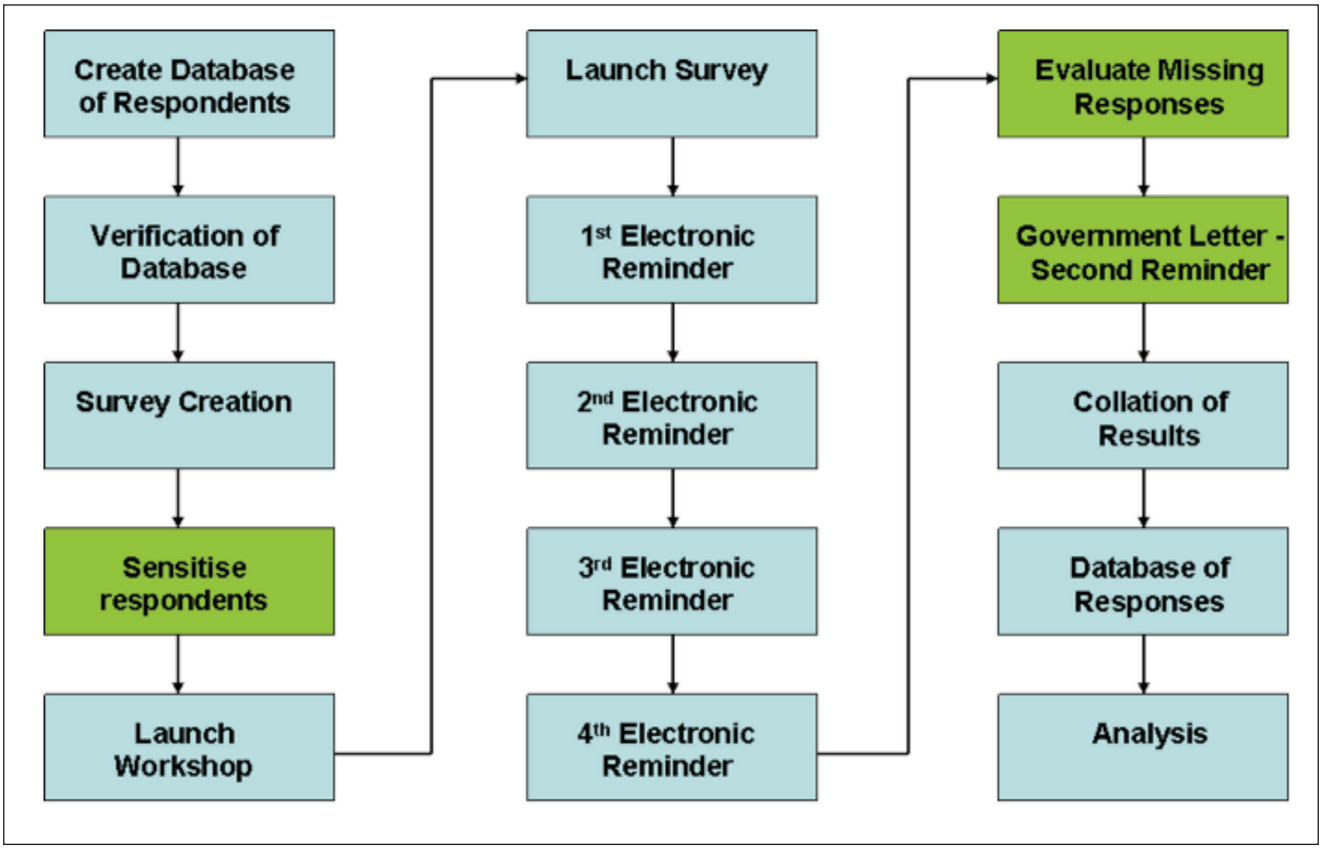


***Figure 6.2** - Operational Methodology*



6.3 Areas of Coverage

In order to place the KNSI Survey into perspective, UNIDO conducted a Survey of Surveys of Innovation in EMEs in 2007, and again in 2012. The updated Survey of Surveys of Innovation shows that of the 128 surveys since 1990 in EMEs, none can be strictly defined as a NSI survey, in the sense that the same DASI is applied to the constituents of the NSI[5], namely: leadership (Minister, Deputy Minister, Chief Director) in Government policy-making (GOV); high-level management (Chief Executive Officers) in Medium High-Tech Industry (MHTI); leadership (faculty deans and departmental heads) in Knowledge-Based Institutions (KBIs); and leadership (Chief Executive Officers) in Arbitrageurs (ARB), Financial Institutions (FI), Venture Capital (VC), and Knowledge Brokers (KB). A breakdown of the 128 surveys conducted indicates: 60 in Emerging Europe, 34 in Latin America, 19 in Asia, and 15 in Africa and the Middle East.

The initial Ghana National System of Innovation (GNSI) Survey completed in 2012[6], applied the same DASI to the three constituents of the NSI, as well as to a fourth actor, namely Arbitrageurs, who are acknowledged to play a crucial role of intermediation between sources of knowledge and commercialisation of knowledge[7]. The GNSI Survey is the first of its kind[8], and the KNSI survey follows from this lead.

[5] Etzkowitz, H., (2003). Research Groups as 'Quasi-firms': the Invention of the Entrepreneurial University. Research Policy, 32, pp.109-121; Leydesdorff, L., (2005). The Triple Helix Model and the Study of Knowledge-Based Innovation Systems. International Journal of Contemporary Sociology, 42(1); Shinn, T., (2002). The Triple Helix and New Production of Knowledge: Prepackaged Thinking on Science and Technology. Social Studies of Science, 32(4), pp.599-614; Leydesdorff, L., and Meyer, M., (2006). Triple Helix Indicators of Knowledge-Based Innovation Systems: Introduction to the Special Issue. Research Policy, 35, 10, pp.1441–1449; Kapsali, M., 2010. Relating in Project Networks and Innovation Systems. In: DRUID (Danish Research Unit for Industrial Dynamics), Summer Conference on Opening up Innovation Strategy, Organization and Technology. London, UK 16-18 June 2010.

[6] Report authored by Bartels F.L., and Koria, R., (2012). Evidence-Based Policy Making: The Ghana National System of Innovation – Measurement, Analysis and Policy Recommendations, UNIDO, Vienna, December.

[7] As such, knowledge brokers and venture capitalists fill this gap through the provision of links, knowledge sources and even technical knowledge so that firms can improve their performance in terms of survival rate, as well as accelerate and increase the effectiveness of their innovation processes (Zook, 2003; Hargadon, 1998; Baygan and Freudenberg, 2000). Their resource allocation role is based on the assessment of advantages in information asymmetries (Williamson 1969, 1971, 1973; Bartels, *et al*., 2012 p.7). In the Triple Helix type 4 it is posited that the arbitrageur interacts, primarily as an inter-mediator, with Industry, KBIs and Government and not only provides the necessary financial, legal and information inputs to the system, but also when appropriate, assumes equity position, mentoring and other investor roles.

[8] Bartels, F.L. Koria, R. and Carneiro, S., (2009). National Systems of Innovation in Selected Emerging Market Economies: an Examination of Actors, Interactions and Constraints. In: EAMSA (Euro-Asian Management Studies Association), 26th Conference on Globalization of Technology, Innovation and Knowledge. Lausanne, Switzerland 22-24 Oct. 2009.

Table 6.1- *KNSI Universe and Convenient Sample of Respondents*

Actor	Universe of Respondents	Convenient Sample	Responses	Response Rate (%)
Government	50	46	26	56.52
MHT Industry	169	109	53	48.62
Knowledge-Based Institutions	428	353	164	46.46
Arbitrageurs	119	112	25	22.32
All Actors	**766**	**620**	**268**	**43.22**

Note: the convenient sample represents Respondents whose contact details were verified through the verification protocol developed by Bartels and Koria (2012).

The KNSI Survey obtained valid and reliable responses as shown in Table 6.1.

6.4 Types of Documents Covered

In order to arrive at a comprehensive view of the policy orientation of the GoK with respect to STI within the national economy, a number of GoK policy documents were reviewed and textually analysed. The results of the analysis are presented in Chapter 8 of this report. The analysis shows the extent to which there is commitment to the role of STI within the economy, inter-ministerial policy coherence, as well as the policy convergence. By way of signalling Chapter 8 in general in the policy documentation, there is either an under-emphasis on, or an absence of, indicators for achieving targets, and monetary and fiscal dimensions, as well as incentives, performance requirements and regulatory aspects to targets, are absent.

The following documents were analysed:

- Kenya National Industrialization Policy Framework (2010)
- A policy framework for Science, Technology and Innovation (2012)
- National Information and Communications Technology Policy (2006)
- Kenya Vision 2030, A Globally Competitive and Prosperous Kenya (2007)
- The Kenya National ICT Masterplan (2014)
- Science, Technology and Innovation, Medium Term Plan for 2008-2012 (2008)
- A Policy Framework for Education (2012)
- A Review of Kenya's Current Industrialization Policy (2000)
- The Master Plan Study for Kenyan Industrial Development (MAPSKID) in The Republic of Kenya (2007)
- Framework for capturing and tracking innovation (2011)
- The Science, Technology and Innovation Act (2013)
- Science, Technology and Innovation Policy and Strategy (2008)

6.5 Structure of the Report

The report is structured in 11 chapters, the substantive being Chapter 5 – Executive Summary – which presents the salient features, key findings and messages of the Report. Chapter 6 – Introduction – introduces the report in terms of context, purpose, and guiding principles. It indicates provenance, activities undertaken, areas covered and documents analysed, etc. Chapter 7 – Overview of the NSI Concept and Introduction of the 'Triple Helix' type 4 – presents the rationale and analytical framework for approaching the mapping and measuring of NSI. It indicates the evolving definition of the term NSI, as well as the relationship between the NSI, its Actors and economic development. Chapter 8 – Country Level Coherence – portrays the articulation of national policy priorities with respect to science, technology and innovation. The chapter reviews innovation policy with respect to industry, science, technology and Information and Communications Technology (ICT), as well as education. Chapter 9 – Policy Analysis, Implications and Recommendations – presents the overall policy analysis in terms of the statistically significant analytical results. It discusses the policy implications and suggests policy recommendations. Chapter 10 – Policy Recommendations Matrix – presents the policy recommendations in terms of a policy matrix framed in time and space. The policy matrix provides a 'helicopter' view of the KNSI policy landscape in terms of priorities, targets and measures for implementing policy on innovativeness and innovation. Chapter 11 – References – lists the sources of empirical and theoretical foundations that have underpinned the survey work, data analysis and data interpretation to arrive at policy recommendations.

7.0 Overview of the NSI Concept and Introduction of the 'Triple Helix' Type 4

This chapter introduces the conceptual and empirical basis for addressing the NSI as a crucial matter of policy concern (Samana, 2012; Ushakov, 2012). Innovation is increasingly viewed as the salient ingredient in the sustainable growth of the modern economy (Furman *et al*., 2002; Bartels and Koria, 2014; Bartels *et al*., 2014). A nation must access information and develop technological capacity, and hence industrial productivity capabilities, if it does not wish to find itself on the down side of the cross-country income distribution (Quah, 1996, 1997; Jones, 1997).

The quantity and rate of technological innovation and the quality of competitive advantages generated by the NSI are ultimately determined by factors such as the density, distribution, directionality and symmetry of inter- and intra-organisational relationships between, and within, core Actors; the level of available resources; the governance and policy management of co-operational and conflictual contexts that arise because of agency problems and managerial utility in, and among, Actors. These relationships determine the coherence of the data, information, skills and knowledge available, as well as their inter-linkages and reciprocating exchanges of value among key Actors in the NSI. Concepts and explanations that underpin the policy awareness of the dynamics of economic and social development through innovation are increasingly systemic (Antonelli, 1999; Cohendet, *et al*., 1999). The conceptual and empirical articulations are framed in terms of understanding networks and interactions as Complex Adaptive Systems (CAS), with respect to properties of non-linear systems, knowledge generation and flows (Bartels, *et al*., 2012; Bartels *et al*., 2012; Bartels and Lederer, 2009; Nelson and Winter, 1982; Dosi, *et al*., 1988; Leydesdorff and Van den Basselaar, 1994).

The NSI is one such non-linear phenomenon that can be managed through evidence-based policy analysis. Complex adaptive systems, broadly speaking, are systems that exhibit emergent behaviour due to interactions between their component elements. They are characterised by interconnectedness, feedback loops, non-linear change and tipping points, and emergent properties at the macro-level which need to be understood holistically.

A perspective provided, at the turn to the 21st century, by the 1999 Conference on "National Innovation Systems, Industrial Dynamics and Innovation Policy" (DRUID, 1999), showed that the taxonomy of NSI encompassed at least eight dimensions. These included: methodological; knowledge; learning; organisational, inter-industry and inter-firm linkages; growth and industrial renewal; NSI in developing countries; globalisation and NSI; and, NSI policy. The 2012 Conference on "Innovation and Competitiveness: Dynamics of Organisations, Industries, Systems and Regions" (DRUID, 2012), showed that the concept and empirics of NSI encompassed 15 dimensions. These are: Systems of Innovation; Markets and Entrepreneurship; Organisational Strategy and Innovation; Firm theory and empirics; Knowledge Networks; Intellectual Property Rights; KBIs and Governance; Eco-Innovations; Innovation under Financial Crises; Organisational Creativity; Institutional Dynamics; Labour-Capital Mobility; Regional Clusters and Growth; Public-Private Partnership Policy; Innovation and Economic Development. These further dimensions denote the evolution and dynamism of NSI and its contribution to economic competitiveness. They also shed light on why considerable efforts have been made by several countries to measure the dimensions, factors and variables of innovation. However, these efforts have not mapped and measured the NSI effectiveness, efficiency and performance, at varying levels (meta, macro, meso and firm)[9].

At the meta level, the global aspect of NSI and internationalisation of alliances between firms and networks, especially with respect to technology and R&D activities, is illustrated by Archibugi and Iammarino (1999), Blanc and

[9] A Survey of Surveys of Innovation in 30 emerging market economies carried out by UNIDO in 2007 and updated in 2012 shows that 128 such surveys have been performed since 1990. However, none of these surveys is a National System of Innovation Survey. All the Innovation Surveys were targeted only to Respondents from industry. In contrast, a NSI Survey targets government policy leaders; leaders in knowledge-based institutions; chief executives of firms in medium- and high-technology industries; and chief executives of arbitrage and venture capital companies.

Sierra (1999) and Carlsson (2006)[10]. Their findings highlight the important role of KBIs, namely universities, private and public research centres, engaged with international firms in research based techno-scientific collaborations[11]. These Actors – plus Government – are at the core of the NSI as a "neo-evolutionary" model of university-industry-government interactions, known as the ''triple helix'' (Leydesdorf, 2001). A secondary perspective at the meta level adds two further aspects to the description of NSI, namely informality/formality and distance from the innovation process. Informality is central to networking and the development of the social capital that lubricates formally the functioning of the NSI (Bartels, 2005; Schoser, 1999). A characterisation of NSI at the macro level leads us to the work of Bjørnskov and Svendsen (2002) who use decentralisation and social capital to demarcate the notable economic performance of Scandinavia. In contrast, Asheim and Coenen (2004) and Munk and Vintergaard (2004) develop a meso or cluster-based taxonomy in which the importance of the knowledge base and the nature of organisational capital, and institutional characteristics and involvement in innovation, are key factors. Narrowing the focus further to the firm level, Braadland and Anders (2002) include skills and the systemic nature of innovation in their classification of NSI. These varying approaches that characterise NSI reflect differing purposes of inquiry, focus and policy.

To fully delineate the NSI, we take departure from the evolution of the definition of NSI in order to inform the policy rationale for carrying out the KNSI survey.

"[...] the network of institutions in the public and private sectors, whose activities and interactions initiate, import, modify and diffuse new technologies." (Freeman, 1987, p.1)
"[...] the elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge [...] and are either located within or rooted inside the borders of a nation state." (Lundvall, 1992, p.2)
"[...] a set of institutions whose interactions determine the innovative performance [...] of national firms." (Nelson and Rosenberg., 1993, p.4)
"[...] the set of institutions and economic structures affecting the rate and direction of technological change in the society." (Edquist and Lundval, 1993, in UNIDO, 2005, p.10)
"[...] the system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction among these Actors may be technical, commercial, legal, social and financial, in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology." (Niosi, *et al*., 1993, p.212)
"[...] the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country." (Patel and Pavitt, 1994, p.5)
"[...] that 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." (Metcalfe, 1995, p.38)
"The National Systems of Innovation approach stresses that the flows of technology and information among people, enterprises and institutions are key to the innovative process. Innovation and technology development are the result of a complex set of relationships among actors in the system, which includes enterprises, universities and government research institutes" (OECD, 1997, p.7).
"[...] the envelope of conforming policies as well as private and public organisations, their distributed institutional relations, and their coherent social and capital formations, which determine the vector of technological change, learning and application in the national economy." (Bartels, *et al*., 2012, p.6)

From the evolution of the definition of NSI, it is evident that there are certain recurring concepts, for example, Actors organised (formally and informally), knowledge transfer, skills, linkages and interaction, and technological learning and change. Interestingly, physical assets, although undoubtedly important, are not emphasised in these definitions. The evolving definition of the NSI enables a 'stocks' and 'flows' perspective. In this view, institutions, in the dual sense of organisations, as well as the 'rules of the game' (North, 1991), constitute the 'stocks' of the NSI. The transfer of tacit 'know-how' (to whatever extent possible), and codified knowledge, constitutes the 'flows' within the NSI. Phrased differently, NSI consist of linkages (formal and informal) and their intensity between institutions that facilitate intellectual flows and exchange of knowledge resources in the economy (Buckley and Carter, 2004). The fundamental enabling factors for these flows are the policy environment, the rate and extent of learning, and their embeddedness in organisations (taking into account the influence of geography and location) (Marshall, 1920). The effectiveness and efficiency of the stocks of, and flows in, the NSI determine ultimately the technological competitiveness of the national economy.

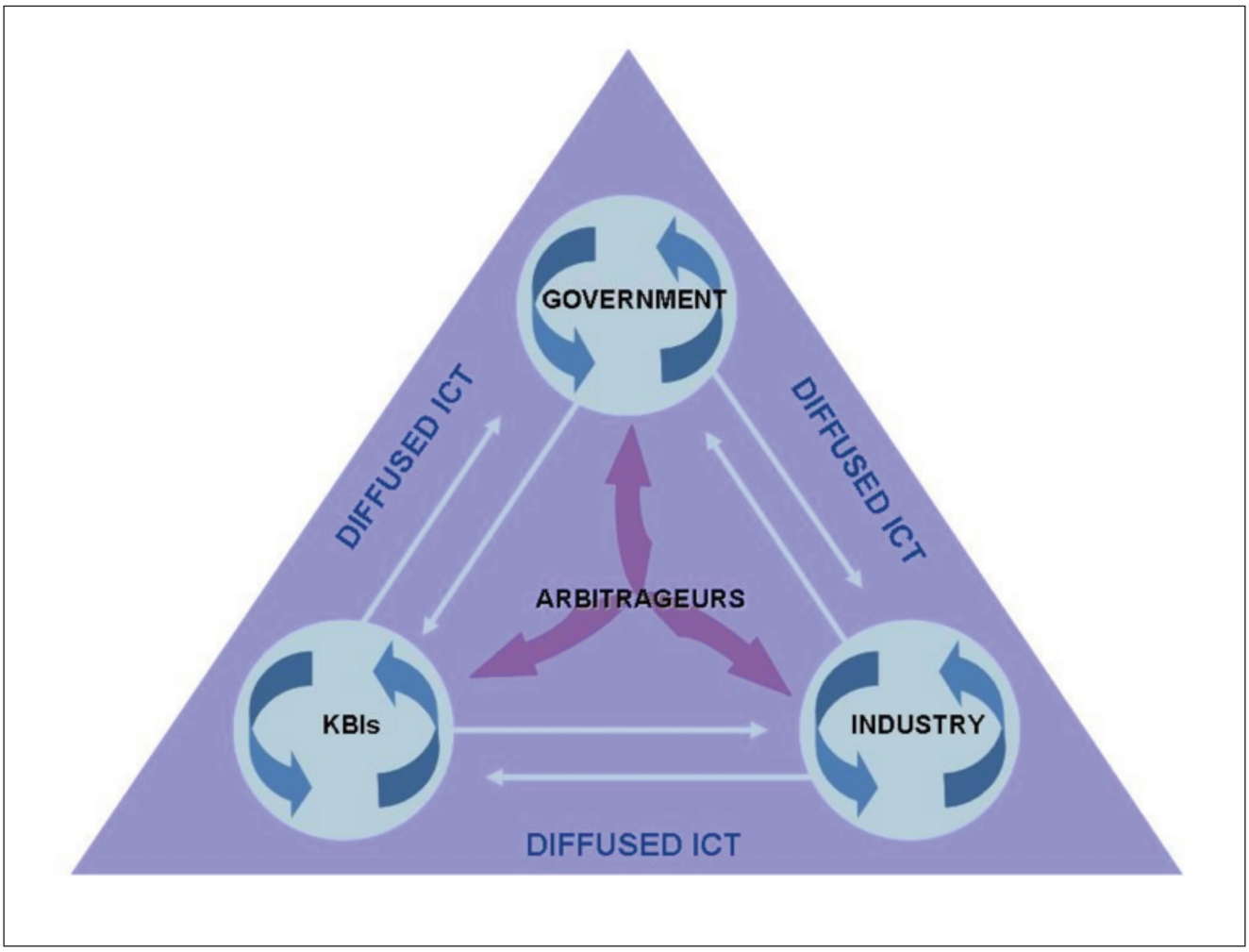
However, given the definition that alludes to the 'envelope' of conforming policies, there are two aspects that are excluded from the traditional framing of NSI that we include in our

[10] For a review of the NSI concept, see Lundvall (2007).

[11] See also Dunning, J.H., (1997). Alliance Capital and Global Business. London: Routledge, for an appreciation of the increasing networked nature of international businesses including the offshore outsourcing of knowledge work.

framework and methodology (Bartels, *et al*., 2012). These are namely the effects of diffused ICT, and Arbitrageurs (Koria *et al*., 2014; Bartels and Koria 2014). Through the spread of digital information and ICT, new modes of development have evolved (Perez, 1983; Freeman and Louça, 2001). Our inclusion of ICT in NSI is not based solely on the concept of access, but on the work of Hilbert *et al*. (2010), who view the digital divide as being attributable to issues of storage; the ability to compute and transmit digital information; to contextualise not just the quantity of hardware but also the corresponding performance in relation to all four NSI Actors as depicted in the Triple Helix type 4. Within the developing country context, the three Actors (Government, KBIs and Industry) are perceived to hold relatively traditional and separate roles, with little or no overlap in function, i.e. in contrast to "entrepreneurial academics, academic industrialists, and business strategy in government" (Ekztowitz, 2002, p.117). This is evidenced by the lack of bodies, such as technology transfer or licensing offices within universities, or widespread presence of venture capitalists. Therefore, access to the necessary financial and information resources would lead to the need for independent institutions, namely Arbitrageurs. Figure 7.1 illustrates this framework as the Triple Helix type 4. It is the basis for measuring the KNSI, and hence provides the framework for policy analysis, policy implications and policy recommendations in the context of the articulation of the national priorities of the GoK.

Figure 7.1 *– Triple Helix Type 4*



8.0 Country Level Coherence – Articulation of National Policy Priorities

8.1 Overview

This chapter focuses on a selection of GoK policy documents within the framework of the KNSI Survey. These documents are reviewed for an understanding of the interconnected policies the GoK has developed to enhance the role of innovation and competitiveness in the national economy.

Furthermore, this chapter examines the directives established by Kenyan policy-makers to discern the economy's competitiveness in Technology and Innovation, and how synergies among the four NSI key Actors [Governments, KBIs, Industry and Arbitrageurs] can influence policy implementation.

The following sections present textual analysis of four different policy areas. The first reviews policy documents related to industry as a key driver in development. The second provides a contextual analysis on Science and Technology, and ICT, in terms of their strategic potential for contributing to socio-economic growth. The third examines the importance of Education in enhancing innovation and technology as a base for economic transformation in Kenya. The last section analyses Kenya's long-term development agenda, covering economic, social and political Governance decisions.

The policy documents selected to highlight the GoK commitment to the role of its NSI in industrialization are indicated in section 6.4 – Types of Documents Covered.

The purpose of this review is a textual analysis of the listed policy documents showing reference to, and interactions with, the key NSI Actors with regard to how coherent, measurable and workable the policies and strategies are, with respect to Industry, Science and Technology, ICT, and Education. However, this policy analysis is performed bearing in mind the challenges that Kenya's institutions face, and the adaptability of the NSI framework to the Kenyan socioeconomic context. Necessarily, the policy documents inspect key overarching themes, and the strategies elucidated also have recurrent schemes for achieving policy objectives.

To elaborate an effective and efficient set of policies for industrialization, it is necessary to apprehend, through mapping and measurement, the linkages amongst the key Actors in the NSI in order to improve Kenya's technological and economic performance. These interactions, if purposefully nurtured and stimulated by the Government, can propel Kenya to higher middle-income status.

8.2 Policy Review on Industry

This section gives a broad overview of the industrial policy documents in Kenya with regards to STI in Industry, ICT for Industrial Development, and R&D to enhance industrial growth and to implement the Public-Private Partnership (PPP) agenda of the GoK.

The Kenya National Industrialization Policy (2010) identifies the industrial sector as the potential leading growth driver, capable "to create employment and lead in contribution to GDP so as to offer sustainable better lives for Kenyans", in line with the aspirations of Vision 2030 (Ministry of Industrialization, 2010, p.4). To meet these goals, the sector has to become more efficiency driven, raising productivity closer to that of Kenya's external competitors. Despite the long tradition of manufacturing in Kenya, the sector has experienced a continuous decline in investment and overall lack of competitiveness, which is mainly caused by: expensive and often low quality raw materials, rising but uncompetitive productivity adjusted labour costs, unreliable and expensive energy; low capital productivity, as compared to regional and global levels; inefficiency in the local transport and logistics sector; an unfavourable business environment created by heavy regulation, weak trade agreements, lack of rigorous legal enforcement, incidences of insecurity and limited access to capital (Government of the Republic of Kenya, 2007, p. 72).

In order to revolutionize the growth of the industrial sector, the policy emphasizes increased productivity and competitiveness as key guiding principles for expanding and maintaining the domestic and export markets. The Kenya Vision 2030 recognises that science, technology and innovation play a central role in meeting rapidly changing consumer tastes

and preferences, as well as in boosting productivity and competitiveness of the industrial sector. The Ministry of Higher Education, Science and Technology, states that, "The Government will promote STI as a means to make Kenyan products and services globally competitive. The Government will therefore seek to entrench innovation in all national production systems. Through STI, new knowledge-intensive industries will be created, in addition to transforming the industry structure and mix of products" (Ministry of Higher Education, Science, Technology, 2012, p.28).

Creating an enabling environment through improved infrastructure for industrial development is one of the prime mandates of the Government. Kenya National Industrialization Policy states that "effective and reliable infrastructure is an important key enabler for growth and sustainability of industrialization. It is also critical in lowering the cost of doing business and enhancing competitiveness of the country. This infrastructure entails transport and logistics systems, road and rail networks, sea and inland waterways, air transport, energy supply; water and sewerage services; and ICT services" (Ministry of Industrialization, 2010, p.8).

The GoK has considered ICT to be at the core of industrial development and human progress, and capable of creating an immense impact on the way services are delivered. "Kenya witnessed tremendous growth in the sector in 2009, following landing of the underground sea fibre optic cable […] ICT is a key enabler in lowering the cost of doing business" (Ministry of Industrialization, 2010, p. 11). The Ministry of Information and Communications calls for investment in R&D in this sector to promote local industrial growth and hasten technology transfer. University and tertiary institutions are encouraged to undertake R&D activities in collaboration with telecommunications service providers and manufacturers (Ministry of Information and Communications, 2006).

In addition, to promote industrial development, the GoK emphasizes the need to promote the development of Micro, Small and Medium Industries (MSMIs). The MSMI sector is acknowledged to be the foundation of industrial development in most developing and developed countries. In Kenya, the sector suffers from lack of access to affordable finance, limited access to markets, a lack of infrastructure, hostile business environment, weak management structures, and lack of access to skilled labour. The GoK aims to: "fast track the enactment of the Micro, Small and Enterprise Bill; establish an Industrial Development Fund (IDF); develop a National Industrial Incubation Policy; develop a 'one-stop shop' for business registration, licensing and taxation for MSMIs; develop a National Industrial Subcontracting Policy" (Ministry of Industrialization, 2010, p.12).

An effective intellectual property rights (IPR) system is also indicated as an important incentive to innovation. "Kenya has a legal and institutional framework for administering IPRs and is affiliated to the World Intellectual Property Organization (WIPO). However, there is lack of a national IP policy and the institutional framework is weak, hampering the effectiveness of the IP system, acting as a disincentive to innovation; low awareness on importance of IP registration; and loss of revenue and royalties to the innovators and protection of Kenyan products" (Ministry of Industrialization, 2010, p. 14). It is thus the Government's mandate to ensure the protection of intellectual property rights.

The GoK acknowledges that the development of technical, production and managerial skills is essential for the expansion of the industrial sector. Kenya thus aims to "create a globally competitive and adaptive human resource base to meet the requirements of the Vision 2030. This will require strengthening of linkages between training institutions and industry; development of technical, production and managerial skills in a well-structured and coordinated manner" (Ministry of Industrialization, 2010, p.15).

8.2.1 Policy Strategies and Incentives

The strategies for promoting research, development and innovation for industrialisation include to: "develop a framework for commercializing research findings; formulate mechanism to facilitate collaboration with the private sector in research, technology and development; strengthen capacity for technology certification and adoption; establish a funding mechanism for research and development to facilitate innovation, acquisition of strategic and relevant technology for industrial development; establish an industrial information database" (Ministry of Industrialization, 2010, p.16).

In order to improve the performance of the ICT sector and strengthen the role of industrialization, the Kenya National Industrialization Policy indicates the following strategies: "fast track the provision of ICT infrastructure to areas of existing and high potential for industrial development […]; promote the use of ICT in transport and logistics systems, manufacturing processes and all industrial related activities to enhance cost effectiveness and efficiency" (Ministry of Industrialization, 2010, p.11).

In order to promote standards and quality infrastructure for industrialization, the GoK indicates the need to: "fast track the harmonization and implementation of EAC and COMESA common quality standards; develop a national quality, standards and anti-counterfeit policy; strengthen and operationalize the Standards and Tribunal to enhance arbitration of violation of quality and standards" (Ministry of Industrialization, 2010, p.13).

To promote IPRs for industrialization, the Ministry of Industrialization proposes to: "develop and implement a National IP Policy; increase awareness on intellectual property rights (IPR); strengthen the Kenya Industrial Property Institute and the Industrial Property Tribunal to enhance institutional capacity of IPR and arbitration" (Ministry of Industrialization, 2010, p.14).

To achieve the goal of development of technical, production, managerial and entrepreneurial skills needed for industrialization, the GoK strategies include to: "develop curriculum in tertiary and vocational training institutions aligned to the industry skills requirements; develop a framework for continuous linkages between tertiary and vocational training institutions, and industry; expand and modernize technical, vocational and entrepreneurial training institutions offering artisan, craftsmanship and technician training for industry; establish entrepreneurial centres of excellence for business development services for Micro, Small and Medium Industries" (Ministry of Industrialization, 2010, p.15).

8.3 Policy Review on Science, Technology and ICT

Capabilities in STI are significant determinants of progress and transition to knowledge sharing and diffusion in order to facilitate new innovations that enhance productivity increases. STI represent powerful tools for developmental policies to utilize key resources for economic growth, particularly the use of scientific and technological knowledge and their related institutional externalities.

The Kenya Vision 2030 recognises the role of science, technology and innovation (STI) in wealth creation, social welfare and international competitiveness. Kenya intends to become a knowledge-led economy, and science, technology and innovation are considered as the foundations of a knowledge economy. Universities and research institutions are acknowledged as key drivers of innovation systems and the resultant developments in STI and application of knowledge, especially in biotechnology, value addition, manufacturing, Information and Communication Technologies (ICT). The aim of GoK is to promote STI as a means to make Kenyan products and services globally competitive. It intends to adopt a new Kenya national innovation system to ensure that the education and research system, business system, intermediate organizations, STI infrastructure, and framework conditions in which they operate interact effectively and efficiently to respond to the national needs (Ministry of Higher Education, Science, Technology, 2012; Government of the Republic of Kenya, 2007).

The objectives of the Kenya Science, Technology and Innovation Policy are to: strengthen the technical capacities and capabilities of STI, university education, technical, vocational and entrepreneurial training institutions and systems; develop a core mass of highly skilled human resources; intensify innovation in priority sectors including setting up a functional National Innovation System; enhance awareness on the role of knowledge in enhancing productivity among policy makers, implementers and beneficiaries; develop and implement a mechanism for sustainable funding of STI (Ministry of Higher Education, Science, Technology, 2012).

The Kenya ICT Master Plan 2017, which is aligned to Vision 2030, is focused on driving real economic growth through the promotion of the ICT sector. The vision of the Master Plan is 'Kenya as an ICT hub and a globally competitive digital economy' with the following six guiding principles: partnership; equity and non-discrimination; technology neutrality; environmental protection and conservation; good governance; and incentivising.

The plan has three pillars. First, it aims to enhance the quality of life for all Kenyans through affordable, accessible and available ICT. Kenya intends to attain +90 percent inclusion of Kenyan society to public services, information and knowledge through ICT. Second, the Ministry of Information and Communications aims to develop a globally competitive ICT industry as the foundation of a knowledge economy. This includes the establishment of smart parks, smart infrastructure, smart platforms and centres of excellence that attract foreign direct investment, and create employment. Finally, Kenya aims to strengthen ICT to significantly enhance the productivity, global competitiveness and growth of the key Vision 2030 economic sectors.

The Kenya National Information and Communications Technology Policy (2006) indicates lack of a comprehensive policy and regulatory framework, inadequate infrastructure, and insufficient skilled human resources as the main challenges of the ICT sector. The GoK therefore emphasizes the need for a comprehensive policy, legal and regulatory framework to: "support ICT development, investment and application; promote competition in the industry, where appropriate; ensure affordability and access to ICT nationally; address issues of privacy, e-security, ICT legislation, cyber-crimes, ethical and moral conduct, copyrights, intellectual property rights and piracy; support research and development in ICT; and develop an institutional framework for policy development and review" (Ministry of Information and Communications, 2006, p.4).

In order to ensure the existence of adequate ICT infrastructure, the emphasis will be placed on: "provision of support infrastructure, such as energy and road; supporting software development; promotion of local manufacture and assembly of ICT equipment and accessories; and provision of incentives for the provision of ICT infrastructure" (Ministry of Information and Communications, 2006, pp.4-5).

The GoK recognizes the role played by the various institutions providing ICT education and training. However, it indicates "the need to strengthen and streamline the training through: promoting ICT in education at primary, secondary, tertiary and community levels […]; setting up a framework for evaluating and certifying ICT training programmes; developing a mechanism for attracting and retaining skilled human resources; establishing networks for sharing training resources; and developing strategies to support research and innovation" (Ministry of Information and Communications, 2006, p.5).

8.3.1 Policy Strategies and Incentives

In order to improve the Kenya National Innovation System, GoK strategies include to: fill in the policy formulation and implementation gaps, as well as addressing the implementation weaknesses inherent within the current KNSI; harness the resources needed to support the mainstreaming of STI in the Kenyan economy; generate and manage Intellectual Property Rights, develop; transfer and diffuse technology; modernize, and utilize indigenous resources, practices and knowledge; and "enhance STI linkages and collaboration" (Ministry of Higher Education, Science, Technology, 2012, p.14).

The GoK intends to allocate one percent of GDP annually for the R&D sub-sector and motivate other stakeholders to participate in funding STI. The Government aims to increase the public investment for universities, laboratories and research institutions, create a National Research Fund to support both basic and applied research, establish and finance infrastructure and equipment needs for STI, identify existing domestic and foreign technologies and adapt these to address Kenya national priorities (Ministry of Information and Communications, 2006, p.22).

In order to address the lack of adequate and skilled labour force, Kenya aims to take measures that improve the national pool of skills and talent through training. The Government intends to favour the transition from secondary level education to university and strengthen the postgraduate training, particularly in science and technology. The Ministry of Higher Education, Science and Technology also aims to develop a mechanism to retain the highly talented Kenyans from the education system and attract the best from the diaspora, and to promote innovative in-house R&D in both public and private enterprises through incentive schemes and public-private partnerships (PPP).

Kenya also aims to strengthen the capacity of local firms, particularly micro-, small- and medium-scale enterprises (MSMEs), to identify and assimilate new and existing knowledge and increase their regional and global competitiveness. In this regard, the Government intends to implement various programmes to upgrade the skills and technical competencies of both workers and owners of MSMEs, and increase their productivity and level of technology utilization. The GoK also emphasizes the need to enhance the capacity to effectively leverage indigenous resources and knowledge (Ministry of Science, Technology and Innovation, 2008, pp. 14-15).

The GoK aims to promote the use of ICT and position the country as a regional ICT hub. The actions that it intends to undertake are designed to develop quality ICT infrastructure, integrated and secure information infrastructure and develop critical mass of high-end ICT human capital. Specific ICT strategies include to: integrate ICT in schools, colleges and universities curriculum for non-ICT subjects; work with industry to develop structured ICT training for professionals in all areas; do continuous communication on the role of ICT in national development; implement awareness programmes on the role of information and ICT for quality life; assure a competitive and strategic recruitment regarding the ICT Authority's (ICTA) new organisational structure; build technical and leadership capacity in ICTA; review the terms of services of ICTA staff and make them competitive; institutionalise a performance evaluation system at all levels of ICT professional staff; promote inclusive broadband connectivity by enabling infrastructure providers to roll out affordable 'last-mile' connectivity; develop, implement and institutionalise a cyber-security management framework; consolidate, develop and implement shared infrastructure and services management policies, standards and structures; develop and institutionalise an integrated public data and information sharing infrastructure; transform public service by developing an environment that values data and information sharing culture, streamline governance structures for managing information sharing through a public-sector data sharing programme; develop and institutionalise a legal framework to enable data and information across Governments, citizens and ministries, departments and agencies; develop and institutionalise a middleware platform to secure data and information access; develop a cyber-security policy (Ministry of Information Communications and Technology, 2014).

The Government also intends to establish a dedicated department responsible for science, technology and innovation. It will be in charge of policy, planning and funding of the STI sector, and will house three state agencies: the National Commission on Science, Technology and Innovation (NACSTI); the Kenya National Innovation Agency (KENIA); and the National Research Fund (NRF). The mandate of NACSTI will be to enhance co-ordination of national STI. It will ensure timely and relevant advice to the Government on matters of STI in addressing national priorities (Ministry of Science, Technology and Innovation, 2008, p.33).

KENIA will be responsible of developing and managing the Kenya National System of Innovation. Among the agency's functions, some key ones are: institutionalise linkages between universities, research institutes, private industry, government and other actors in the national innovation system; facilitate the creation of specialised innovation centres of excellence in priority sectors; create synergies among different technological innovations, incubations and diffusion initiatives in Kenya; promote increased awareness, knowledge and information of the innovation system; and implement the research and commercialisation policy.

The mandate of the NRF will be to mobilize and manage financial resources for the Kenya National System of Innovation in order to create knowledge, innovation and development in all fields of science and technology, including indigenous knowledge (Ministry of Higher Education, Science and Technology, 2012).

8.4 Policy Review on Education

Education is one of the most important areas in the development of the NSI and a key dimension in the creation of a knowledge-based economy. In absolute terms, the education sector in Kenya has experienced massive expansion in enrolment and number of institutions over time. The increase has been accelerated by the introduction of Free Primary Education (FPE) and Free Day Secondary Education (FDSE) programmes in 2003 and 2008, respectively. The main issues facing the education sector have been challenges of access, equity, quality, relevance and efficiency in the management of education resources. In 2003, the Ministry of Education embarked on a series of reforms geared towards attaining the education-related Millennium Development Goals (MDGs) and Education for All (EFA). The recommendations of the 2003 National Conference on Education and Training informed the development of the Sessional Paper Number 1 of 2005. It outlined short-, medium- and long-sector targets, which included the Attainment of Universal Primary Education (UPE) and Education for All (EFA) by 2015 (Ministry of Education, 2012).

The challenge facing the Government of Kenya is firstly to retain, and secondly to harness, the skills and competencies that are presently being lost and to provide an education system which meets the aspirations of Vision 2030, and which provides young people access to an equitable and relevant quality education. At the heart of the vision is a curriculum which can provide knowledge, skills, competencies and values to enable learners to move seamlessly from the education system into the world of work, with further academic, technical and vocational education adding value to what has been acquired through the schooling system. It shifts the emphasis on knowledge reproduction to knowledge production (Ministry of Education, 2012).

Kenya Vision 2030 places great emphasis on the link between education and the labour market, the need to create entrepreneurial skills and competences, and the need to strengthen public and private sector partnerships. This is considered highly important for the structure and focus of the education system and curriculum. It also has considerable relevance to teacher development at all levels starting from Early Childhood Development and Education (ECDC) to university; and trainers for high technology and technical skills. Consequently, the government has given serious consideration to changes to the 8-4-4 structure, the introduction of technical and academic curriculum pathways, and the centrality of ICT in teaching and learning. Kenya Vision 2030 also recognizes the need for a literate citizenry and sets targets for eliminating adult illiteracy whilst increasing learning achievements (Ministry of Education, 2012).

In order to make the curriculum specifically relevant to Vision 2030, the GoK emphasizes the important role played by technology, innovation and entrepreneurship, talent development, and the need for schooling to be more closely related to the world of work. Because technology relies heavily on the use of ICT, the provision of ICT facilities across the education sector will be a government spending priority (Ministry of Education, 2012).

Education and training ensure the supply of adequate and competent human resources necessary for STI development. In this regard, the GoK considers the sector as a key enabler in supporting the establishment of Centres of Excellence, curriculum review to articulate STI needs, creating and supply of a critical mass of human resource in technical, Science, Engineering and Technology (SET) skills and numeracy skills, prioritise research and knowledge generation in higher education in STI, technopreneurship training curriculum development, support to technical, industrial, vocational and entrepreneurship training (TIVET) curriculum review and implementation, as well as TIVET structure and qualifications framework, support to co-curriculum STI-related activities, provision of quality STI infrastructure at all levels of education institutions, enabling access to and equitable education training opportunities in STI. The sector is also considered to be important in reinforcing the national capability to make science and technology more appealing and attractive from the early stages of education and in the implementation of specific STI human resource development initiatives, such as science fellowships, research training at university level, adequate supply of modern STI equipment and materials in all the sector's teaching and training institutions, and other policy and educational reforms critical to attainment of STI development (Ministry of Science, Technology and Innovation, 2008).

8.4.1 Policy Strategies and Incentives

Science and technology in education strategies include: mainstreaming STI into the curriculum; establishing and equipping science laboratories in all secondary schools; establishing centres of specialisation for key sectors; and, promoting e-learning at TIVET and university levels (Government of the Republic of Kenya, 2007, p. 102). The Government aims to adequately endow the workforce in the 17-23 age group with skills in targeted industries like ICT, biotechnology, Halal industry, petrochemicals, education, and tourism, including health and eco-tourism. It has also underlined the need to identify factors contributing to the mismatch in supply and demand of skilled and competent human resources, and promote skills training programmes to enhance the employability and productivity of the labour force.

Furthermore, the Ministry of Education, Science and Technology has outlined strategies to enhance the effectiveness of, and harmonise, international science and technology cooperation and collaborations. These strategies are expected to increase involvement of Kenyan scientists and researchers in international STI programmes and projects as stimulus to attract Kenyan researchers and scientists – who

study and work in developed countries – in the participation of domestic STI initiatives; enhance activities in the adoption of advanced foreign technologies and increase foreign aid and support in implementing STI priorities.

The GoK intends to also implement projects aimed to assessing trends in supply and demand for STI graduates and identifying successful policy measures for increasing participation, in particular of women, in scientific and technological education and careers, analysing changes in the mobility of students in science and technology fields, and their implications for policy. These projects will focus on science, technology and innovation education and training at all levels and ages (Ministry of Science, Technology and Innovation, 2008).

The Government also aims to promote the ICT sector in order to assist the STI sector communicate and disseminate information on research, in promotion and awareness creation of STI, enable and support virtual learning, facilitate development and growth of a robust ICT and infrastructure to stimulate and support STI (Ministry of Science, Technology and Innovation, 2008).

8.5 Policy Review on Development

The aim of Kenya Vision 2030 is attaining a "globally competitive and prosperous country with a high quality of life by 2030" (Government of the Republic of Kenya, 2007; p. vii). It aims at transforming Kenya into "a newly-industrializing middle income country providing a high quality of life to all its citizens in a clear and secure environment" (Government of the Republic of Kenya, 2007; p. vii). The vision is anchored on three key pillars: economic; social; and political governance. The economic pillar aims to achieve an economic growth rate of ten per cent per annum and sustaining the same until 2030, in order to generate more resources to address the MDGs. The social pillar seeks to create cohesive and equitable social development in a clean and secure environment. The political pillar aims to realize an issue-based, people-centred, result-oriented and accountable democratic system. The economic, social and political pillars of Kenya Vision 2030 are anchored on the following foundations: macroeconomic stability; continuity in governance reforms; enhanced equity and wealth creation opportunities for the poor; infrastructure; energy; science, technology and innovation (STI); land reform; human resources development; security; and public sector reforms.

Kenya intends to become a knowledge-led economy wherein, the creation, adaptation and use of knowledge will be among the most critical factors for rapid economic growth. Vision 2030 recognises that the emergence of the knowledge economy is always associated with an increase in science-related and technology-related activities. The GoK acknowledges the existence of four elements that allow effective exploitation of knowledge: "an economic and institutional regime that provides incentives for the efficient use of the existing knowledge, the creation of new knowledge, and the flourishing of the entrepreneurship; an educated and skilled population that can create, share and use knowledge well; a dynamic information and communication infrastructure that can facilitate processing, communication, dissemination; and finally an effective innovation system […] that can tap into the growing stock of global knowledge, assimilate and adapt it to local needs, while creating new knowledge and technologies as appropriate" (Government of the Republic of Kenya, 2007, p.20).

The Government has placed emphasis on the role of science, technology and innovation in all aspects of social and economic development in order to foster national prosperity and global competitiveness. It intends to "mainstream science, technology and innovation in all the sectors of the economy through carefully-targeted investments. This is expected to create a strong base for enhanced efficiency, sustained growth and promotion of value addition in goods and services. Kenya also emphasizes the need of a better coordination of its multiple institutions dealing with R&D, and a better STI dissemination strategy" (Government of the Republic of Kenya, 2007, p.20).

Infrastructure is also considered a priority by the Government of Kenya in order for the economic and social development to take place. The 2030 Vision aspires for a country firmly interconnected through a network of roads, railways, ports, airports, water ways, and telecommunications. This includes building infrastructure development to support identified flagship projects to ensure contribution to the economic growth and social equity goals. The GoK also intends to "create an inter-connected, technologically advanced society with modern information and communication systems driving innovation, growth and social progress" (Government of the Republic of Kenya, 2007, p.13).

Furthermore, Kenya aims to create a globally competitive and adaptive human resource base to meet the requirements of Vision 2030. There is a need to create a human resource base that is constantly subjected to re-training and access to technological learning within employment. The standards of technically qualified personnel and professionals must be raised (predictably over time) to international levels. In addition, Kenya's pool of technically qualified personnel and professionals must be matched with skills demand in specific sectors, and not deployed to inappropriate industries or government departments.

The 2030 Vision aims to promote an agricultural sector that is "innovative, commercially oriented and modern farm and livestock sector" (Government of the Republic of Kenya, 2007, p. x). In order to achieve this goal, Kenya intends to improve the agricultural R&D by strengthening human and financial capacities, and increasing the levels of interaction between the Government, the private sector, academic, research institutions and farmers. "In addition, the GoK intends to increase funding on agricultural R&D from KShs 3.2 billion to

the NEPAD recommended level of 2 per cent of agriculture GDP. The structure of funding to agricultural R&D will be reorganised to put more resources into research activities, rather than into overheads and salaries of non-research staff" (Government of the Republic of Kenya, 2007, p. 53).

8.5.1 Policy Strategies and Incentives

Strategies for promoting science, technology and innovation to achieve the Vision 2030 goals include: strengthening technical capabilities; creating high skilled human resources; intensifying innovation in priority sectors; and promoting STI awareness. Kenya aims to create better production processes, with emphasis on technological learning and improve the capacities of STI institutions through advanced training of personnel, improved infrastructure, equipment, and strengthening linkages with actors in the productive sectors. Furthermore, to intensify innovation the Government intends to increase funding for basic and applied research at higher institutions of learning and for research and development in collaboration with industries. Kenya aims also to adopt strategies to coordinate research activities among the various institutions in order to ensure synergy and avoid duplication. Proven technical knowledge produced in industries and tertiary institutions, including universities, will be transformed into technologies and protected as intellectual property rights. Finally, the GoK will take measures to promote awareness of new ideas and discoveries to the general public (Government of the Republic of Kenya, 2007).

Human resource development strategies include: institutionalising learning within employment with emphasis on technological learning; identifying talent within the education sector in order to fast-track it for key career development; identifying and attracting top Kenyan talent from abroad; strengthening linkages between the industry, technical training institutions and research institutions (Government of the Republic of Kenya, 2007).

9.0 Policy Analysis, Implications and Recommendations

9.1 Preamble

The overall assessment and conclusions from the KNSI Survey are, at first sight, not encouraging. The KNSI is hallmarked by: (i) very weak, truncated, perforated and absent linkages within, and between, Actors; (ii) very high barriers to innovativeness, and very high constraints on innovation; and, (iii) largely unsuccessful policy instruments in promoting innovativeness and innovation in the national economy.

However, this overall poor scorecard must be viewed through the lens of Sub-Saharan Africa's generally unprecedented improvements, and Kenya's recent economic performance, in particular.

In 2000, Africa was labelled "the hopeless continent" (The Economist, 13 May 2000). In 2011, The Economist labelled Africa "the hopeful continent" (The Economist, 3 Dec. 2011), indicating, along with the World Bank, that since 2000, "six of the world's ten fastest-growing countries were African. In eight of the past ten years, Africa has grown faster than East Asia, including Japan" (The Economist, 3 Dec. 2011).

The transformation has resulted in Africa's trade with the rest of the world increasing by 200% since 2000, with inflation declining from 22% (1990s) to 8% (2000s), and growth forecasts that average 5.75% in 2012. According to the World Bank (2011), there are five fundamental reasons responsible for this transformation across Africa. First, average growth rates of about 5% since 2000, and over 6% between 2006 and 2008[12]. Second, significant progress on the MDGs. Third, the increasingly attractive investment prospects in Africa's private sector. Fourth, the returns from market-oriented reforms. Fifth, the global demand for energy security which has seen oil exploration in the Rift Valley and the Great Lakes Region[13].

Given such a perspective, the results from the KNSI Survey portend policy advantages that can enable the GoK to achieve its policy objectives regarding innovativeness and innovation.

9.2 Characteristics of KNSI Survey (Sample and Respondents)

The KNSI Survey is based on the GoK Policy articulation of national priorities with respect to enabling the application of higher levels of innovation and innovativeness throughout the economy. It is innovative in its approach, in that it maps and measures the NSI – that is the inter- and intra-relationships (institutional linkages, policy proximity, convergence or divergence, and connectedness) between policy decision-makers at the highest level in Government (GOV), Medium and High-Technology Industry (MHTI), Knowledge-Based Institutions (KBIs), and Arbitrageurs (ARBs), (comprising Financial Institutions (FIs), Venture Capitalists/Knowledge Brokers), respectively[14] – as opposed to carrying out solely a survey of innovation in companies or a review of STI limited to indicators and policy.

The following nomenclature is used texturally with respect to Actors in the KNSI:

KNSI Actor	Abbreviation
All Actors	ALL
Government	GOV
Institutions Supporting Technical Change	ISTC
Medium- and High- Technology Industry	MHTI
Business Enterprises	BE(s)
Knowledge-Based Institutions	KBI(s)
Higher Education	HE
Research Institutions	RI(s)
Arbitrageurs	ARB(s)
Financial Institutions	FI(s)
Venture Capital	VC

It is important to portray the characteristics of the mapping and measuring of the NSI and its survey in terms of the universal population, convenient sample and Respondents. Table 9.1 below indicates the size of the universal population of the four Actors targeted in the KNSI Survey.

[12] "Kenya could be the first EAC country to reach Middle Income status by 2020, but only if it achieves its potential of about 6 percent uninterrupted economic growth. However, if Kenya's economy only grows at 3.7 percent (the average of the last decade), the train will likely be overtaken by Rwanda, Tanzania and Uganda in the next ten years. Middle income status would still be possible, but only by 2037" (World Bank, 2012a, p.1).

[13] See www.africaoilcorp.com/s/operations/current-activities.

[14] From here on in Actors will be referred to by their abbreviation when appropriate, with respect to ease of readability.

***Table 9.1** – KNSI Universe and Convenient Sample of Respondents* [15, 16, 17, 18]

Actor	Universe of Respondents	Convenient Sample (Accessible Potential Respondents)	Percentage of Universe of Respondents
Government[15]	50	46	92
MHT Industry[16]	169	109	64.5
Knowledge-Based Institutions[17]	428	353	82.48
Arbitrageurs[18]	119	112	94.12
All Actors	**766**	**620**	**80.93**

***Table 9.2** – Distribution of KNSI Survey Returns by Actor* [19]

Actor	Convenient Sample	Responses	Response Rate (%)
Government	46	26	56.52
MHT Industry	109	53	48.62
Knowledge-Based Institutions	353	164	46.46
Arbitrageurs	112	25	22.32
All Actors	**620**	**268**	**43.22**[19]

First, the executive policy community essentially the Government (GOV) is represented by high-level officials in the relevant public institutions directly or indirectly responsible for innovation. These include the Ministries of Trade and Industry, Science and Technology, Economy, Finance, Education[20].

Second, the knowledge community in terms of Knowledge–Based Institutions (KBIs) is represented by heads of universities and innovation-related faculties/departments (economics, science, engineering, technology and business) in Higher Education (HE), as well as heads of think-tanks and Research Institutes (RIs). Additionally, privately funded Research Institutes are also considered in this category[21].

Third, the industrial community is represented by the Chief Executive Officers (CEOs and Deputy CEOs) of firms in the Medium- and High-Technology (MHTI) manufacturing sector in accordance with the UNIDO ISIC Rev. 3 classification.

Finally, CEOs and Deputy CEOs in the intermediary body of Arbitrageurs (comprising Financial Institutions (FI), Venture Capitalists and Knowledge Brokers). This group of Actors is not represented in the traditional Triple Helix model, but is of crucial importance as the innovation process requires internal and external intermediation (financial, knowledge, transacting and investment), which has led to new business models and new types of companies in countries with advanced innovation-driven economies.

As such, Arbitrageurs complement the traditional Triple Helix model by the provision of funds, links, knowledge sources and technical knowledge. This enables firms to improve their performance and survival rates, as well as to accelerate and increase the effectiveness of their innovation processes (Zook, 2003; Hargadon, 1998; Baygan and Freudenberg, 2000). The combined intermediation and resource allocation role of Arbitrageurs is based on their assessment of competitive advantages in information asymmetries (Williamson 1969, 1971, 1973).

The maps and tables that follow provide a spatial analysis of the KNSI Actor Respondents in terms of location density (the universe, convenient sample, responses). The universe is in effect a 'Who is Who and Where' in innovation in Kenya[22]. It is the first comprehensive database of policy-makers in GOV, KBI, MHTI and ARB, dealing with innovation. The universal

[15] Leadership in government (Cabinet Secretary and Principle Secretary) policy making.

[16] High level management in Medium-High-Technology Industry (MHTI) - (Chief Executive Officers and Deputy Chief Executive Officers).

[17] Leadership in Knowledge-Based Institutions (KBI) (faculty deans and departmental heads).

[18] Leadership in Arbitrageurs (Chief Executive Officers and Deputy Chief Executive Officers).

[19] In surveys directed towards senior management the general response rate is at 30%. See Harzing, A.W., (2006). Response Styles in Cross-National Survey Research. A 26-country Study. The International Journal of Cross Cultural Management, 6(2), pp. 243-266.

[20] See Annex II- for full list of Government Ministries.

[21] See Annex III- for full list of KBIs.

[22] Due to the innovativeness of the methodology we have names, affiliation, and contact details of the universe of Actors. This database can be used for policy monitoring and evaluation purposes with respect to mobility of human capital between, and within, KNSI Actors (which increases the flows of knowledge within the system).

database constitutes the first of several public goods outcomes from the KNSI Survey. As a key dimension of the effectiveness and efficiency of a NSI is proximity in terms of connectedness and linkages, it is crucial to appreciate the spatiality of KNSI Actors, as it has implications for policy design.

With the exception of KBI, MHTI Actor Respondents, GOV and ARB Respondents are concentrated in the Nairobi region. ARBs are specifically concentrated in the capital Nairobi. KBI, as expected, are distributed in and around Nairobi as well as the Central and Rift Valley regions of the country. The spatial distribution of Actors carries implications in terms of the policy recommendations. Without pre-empting any recommendations, it is clear that with respect to ICT access connecting KBIs in the Nairobi, Central and Rift Valley Regions, is a must in terms of broadband Internet access. Figure 9.1 indicates the distribution of Actors. Tables 9.3 – KNSI Actor by Region (Universe), 9.4 – KNSI Actor by Region (Convenient Sample), and 9.5 – KNSI Actor by Region (Responses) show the exact percentages.

Figure 9.1 *– Spatial Analysis of KNSI Actors' Universe, Convenient Sample and Respondents*

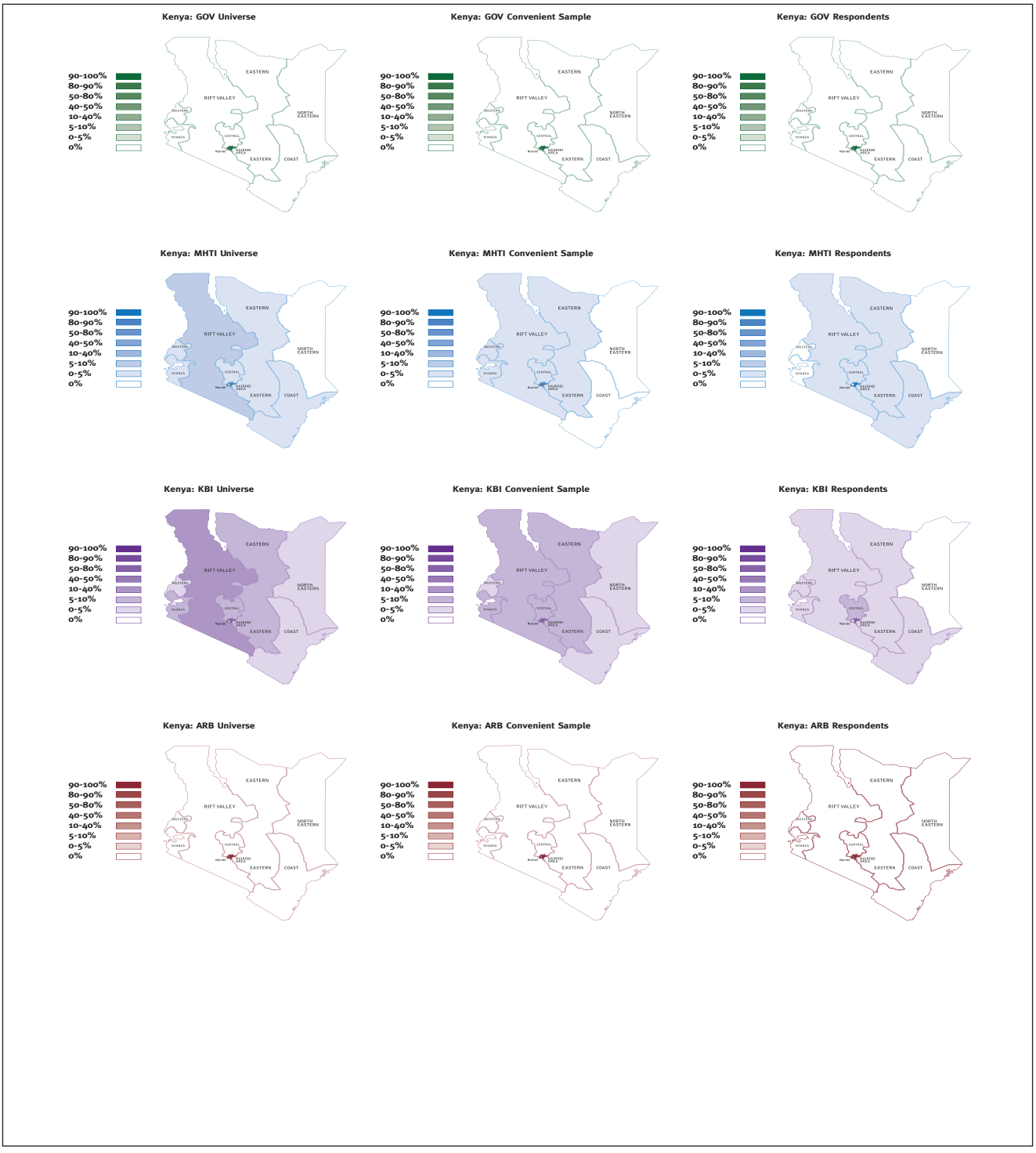


Table 9.3 – KNSI Actor by Region (Universe)

Universe	GOV	GOV (%)	MHTI	MHTI (%)	KBI	KBI (%)	ARB	ARB (%)
Central	0	0	3	1.76	46	10.8	0	0
Coast	0	0	1	.59	14	3.29	0	0
Eastern	0	0	3	1.76	23	5.4	0	0
Nairobi	50	100	151	88.82	247	57.98	120	100
North Eastern	0	0	0	0	1	0.23	0	0
Nyanza	0	0	2	1.18	33	7.75	0	0
Rift Valley	0	0	9	5.29	47	11.03	0	0
Western	0	0	1	0.59	15	3.52	0	0
Total	**50**		**170**		**426**		**120**	
Total of Totals	**766**							

Table 9.4 – KNSI Actor by Region (Convenient Sample)

Universe	GOV	GOV (%)	MHTI	MHTI (%)	KBI	KBI (%)	ARB	ARB (%)
Central	0	0	3	2.68	34	9.77	0	0
Coast	0	0	0	0	13	3.74	0	0
Eastern	0	0	3	2.68	20	5.75	0	0
Nairobi	46	100	100	89.29	210	60.34	113	100
North Eastern	0	0	0	0	1	0.29	0	0
Nyanza	0	0	3	2.68	23	6.61	0	0
Rift Valley	0	0	2	1.79	33	9.48	0	0
Western	0	0	1	0.89	14	4.03	0	0
Total	**46**		**112**		**348**		**113**	
Total of Totals	**619**							

Table 9.5 – KNSI Actor by Region (Responses)

Universe	GOV	GOV (%)	MHTI	MHTI (%)	KBI	KBI (%)	ARB	ARB (%)
Central	0	0	1	2.13	10	5.88	0	0
Coast	0	0	1	2.13	7	4.12	0	0
Eastern	0	0	1	2.13	7	4.12	0	0
Nairobi	26	100	43	91.49	132	77.65	23	100
North Eastern	0	0	0	0	0	0	0	0
Nyanza	0	0	0	0	7	4.12	0	0
Rift Valley	0	0	1	2.13	5	2.94	0	0
Western	0	0	0	0	2	1.18	0	0
Total	**26**		**47**		**170**		**23**	
Total of Totals	**266**							

9.3 Characteristics of KNSI Survey Analysis

The KNSI Survey obtained quantitative data on five dimensions of the NSI, namely

- Constitution of the NSI
- Components of the NSI
- Barriers to Innovation
- Policy Processes
- Measuring Innovative Performance

Actor perceptions of NSI variables in these dimensions were measured by enabling Respondents to express both the direction and strength of their expert opinion (Garland, 1991; Clason and Dormody, 1994) along five point Likert scales, as well as in dichotomous, trichotomous and open questions. There is strong empirical evidence that supports the treatment of ordinal variables as conforming to interval scales (Labovitz 1967, 1970, 1971). In order to ensure the highest validity, reproducibility and reliability of the acquired data, the KNSI Survey instrument used test-retest questions (Easterby-Smith, *et al*., 2012). With respect to test-retest (intra-observer) reliability, this was achieved by repeating certain questions under different dimensions of the survey. This is the basis of test-retest reliability (Kitchenham and Pfieeger, 2002), which allows consistency and significance of responses by Respondents to be validated through statistical analysis.

Not all variables analysed are reported. A selection of variables relevant particularly for policy-makers regarding Actor importance and linkages (inter/intra); level of innovativeness; barriers to innovation and policy instrument success; underlying factors to barriers to innovation; policy instruments and success; and underlying factors to policy success are reported. These are central to policy recommendations and hence the effectiveness and efficiency of the KNSI within the national economy.

The analytical results are based on cross-tabulations, factor and multiple regression analysis which are reported at a statistically significant confidence level of 95% or above. This is of crucial importance when it comes to policy implications arising from the analysis and hence policy recommendations arising from these policy implications. Such significance provides high levels of confidence in the results and the meaningfulness of the results with respect to robust policy craft. It is important to note that the vast majority of surveys on innovation report, as the principle source of analytical information, statistics based solely on frequencies[23].

Cross-tabulation represents a unique combination of specific values of variables. Thus, cross-tabulation allows the examination of statistically significant observations and relationships (in this case, the inter- and intra-linkages between KNSI Actors, and NSI variables). By examining these observations, we can identify systematic relationships between variables through the Chi-square test of significance. This enables us to report results of relationships that are statistically significant and robust. The figures reported, in percentage terms, are imbued with a statistically significant Chi-square value at the confidence level of 95% or above. In other words, the Chi-square analysis indicates the very high level of probability that the KNSI Survey finds evidence in support of systematic relationships between the variables and when repeated would produce similar results[24]. Additionally, when repeated longitudinally, similar systemic relationships between variables (albeit with changing values) would be found. Thus, if the Chi-square probability value is less than or equal to 0.05, there is a significant systematic relationships between the NSI variables examined.

Factor analysis reduces observed variables into factors within a pattern matrix (clusters of inter-correlated variables) with 'mutual interdependence' (Gaur, 1997). The factors represent the underlying structure responsible for the variation of variables in the data, sample and hence the population and universe of Respondents (Kim and Mueller, 1978). The goal of factor analysis is to represent parsimoniously statistically significant relationships among sets of variables while keeping factors meaningful. The statistically significant confidence level in factor analysis is represented by the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. The KMO value indicates the quality of the common factors. A KMO value of 1 represents perfect sampling adequacy. KMO values >0.9 represents "marvellous" sampling adequacy; >0.8 <0.9 represents "meritorious" sampling adequacy; >0.7 <0.8 represents "middling" sampling adequacy; >0.6 <0.7 represents "mediocre" sampling adequacy; >0.5 <0.6 represents "miserable" sampling adequacy; and <0.5 represents "unacceptable" sampling adequacy (Kim and Mueller 1978). In addition, the Bartlett's Test of Sphericity (BTS) significances indicate reproducible and generalisable results of the factor analysis from the sample and hence in the KNSI (Kim and Mueller, 1978, p.54; Kaiser, 1974; Dziuban and Shirkey, 1974, p.359; Rummel, 1970).

Simple regression analysis is used in analysis of the relationship between a single dependent (criterion) variable and a single independent (predictor) variable, as compared to multiple regression analysis which incorporates several independent variables. The objective of multiple regression analysis is to use independent variables, which have known values, in order to predict the value of the dependent variable. In the regression process the independent variables are weighted, as to denote their relative contribution, and thus ensuring maximal prediction of the regression variate (regression equation or model).

[23] Statistically significant confidence levels cannot be ascribed to ordinary frequencies.

[24] This is the purpose of such instrumentation in evidence-based policy making and the use of the DASI longitudinally for policy assessment, monitoring and adjustment.

9.4 Characteristics of KNSI Survey Results

In reporting the KNSI survey results with respect to the cross-tabulations of Likert scale measured variables, the five point Likert scales are dichotomised into the limits of the measurement scale of the statistically significant variables as follows:

- Very Important – Irrelevant (VI-I);
- Very Strong – Very Weak (VS-VW);
- Very Positive – Very Negative (VP-VN);
- Very Strongly – Very Weakly (VS-VW);
- Very High Innovativeness – Very Low Innovativeness (VHI-VLI);
- Very Highly Successful – Not Successful (VHS-NS);
- Very High Constraint – Very Low Constraint (VHC-VLC).

Neutral was assigned to the Irrelevant, Very Weak, Very Negative, Very Weakly, Very Low Innovativeness, Not Successful, and Very High Constraint categories, respectively, on the basis that a neutral perception by an expert Respondent, from the perspective of policy implications and policy recommendations, is not positive. This conservative choice of dichotomisation, or condensation, enables policy implications to be assigned to the policy analysis of the results and permits robust policy recommendations to be made with confidence.

From the KNSI survey instrument selected variables were paired in the cross-tabulations. This provides a mapping of the statistically significant combinatorial measures (at the limits of the scale) of the relationships between the selected policy variables.

In order to orient policy-makers towards the implications, and hence recommendations, the analysis focuses on deficiencies, as well as proficiencies, in the KNSI. The purpose is that available resources (fiscal, monetary, regulatory, standards setting and performance), which may be applied, can be effectively directed and efficiently targeted with requisite accuracy to strengthen the relevant proficiencies and address deficiencies as a matter of sovereign choice, trade-offs and in an order of priority.

With respect to the factor analysis, the factor names were assigned on the basis of the factor loading of the variables associated with each factor, taking the higher loadings into consideration. The naming of factors therefore reflects the variables that are most influenced by the underlying factor. The naming of factors is crucial to a meaningful discussion on policy, and the reporting relies on an understanding of the national environment of STI in Kenya that emerges from qualitative analysis of policy documents as indicated in Chapter 8 above, as well as a judicious use of the international empirical evidence and theory of NSI[25].

[25] For a good overview of factor analysis see Rummel, R.J., (1970). Applied Factor Analysis. Evanston: North Western University Press.

Regarding the multiple regression, based on Ordinally Least Squares (OLS), the regression equation is in the form:

$$Y=C+ \beta_1, X_1 + \beta_2 X_2 + \ldots \beta_i X_i$$

where Y is the dependent (policy) variable; and X_1, X_2 … X_i are the independent (measured) variables of the KNSI. The important statistic of interest is the R^2 (Coefficient of Determination), which indicates firstly how well the regression equation fits the data; and secondly, the extent of variation in the dependent policy variable (Y) that is accounted for by the significant independent measured variables of the KNSI. Thirdly, it enables the prediction of determinant policy variable with a particular measure of confidence. The higher the value of R^2, the higher the accuracy of the policy variable prediction.

9.5 Results of the KNSI Survey

For reasons of space, not all tables generated from the analysis are presented in the report and not all variables of the KNSI analysed are reported. These are available directly from the authors of the report. As previously mentioned, a selection of policy variables namely relevant to: Actor importance and linkages (inter/intra); level of innovativeness; barriers to innovation and policy instrument success; underlying factors to barriers to innovation; policy instruments and success; and, underlying factors to policy success, are analysed and reported.

It is important to re-emphasise that the results presented are from an analysis of the National System of Innovation (NSI), with respect to the system's internal structural relationships between, and within, principal Actors. The results are therefore a view, in terms of a map and measure, of the system's structure and behaviour, and hence its efficiency in parts and effectiveness as a whole. The OECD (1999) points out that the overall efficacy of the NSI is increasingly reliant on the science base, networking and collaboration.

The selected variables that are analysed and reported are specifically:

- Research Institution (RI) linkages with the production system and level of innovativeness of Business Enterprises (BEs);
- Actor importance and strength of inter-, intra-Actor linkages;
- Strength of inter-, intra-Actor linkages and level of innovativeness of Business Enterprises (BEs);
- Factor constraints on innovation;
- Success of policy instruments in promoting innovation and factor constraints on innovation;
- Policy instruments available and success of policy instruments in promoting innovation; and,
- Underlying factors of success of policy instruments in promoting innovation.

In this reporting of the KNSI Survey, the focus is on policy analysis arising from the results, policy implications arising from the policy analysis, and policy recommendations which emerge from the policy implications.

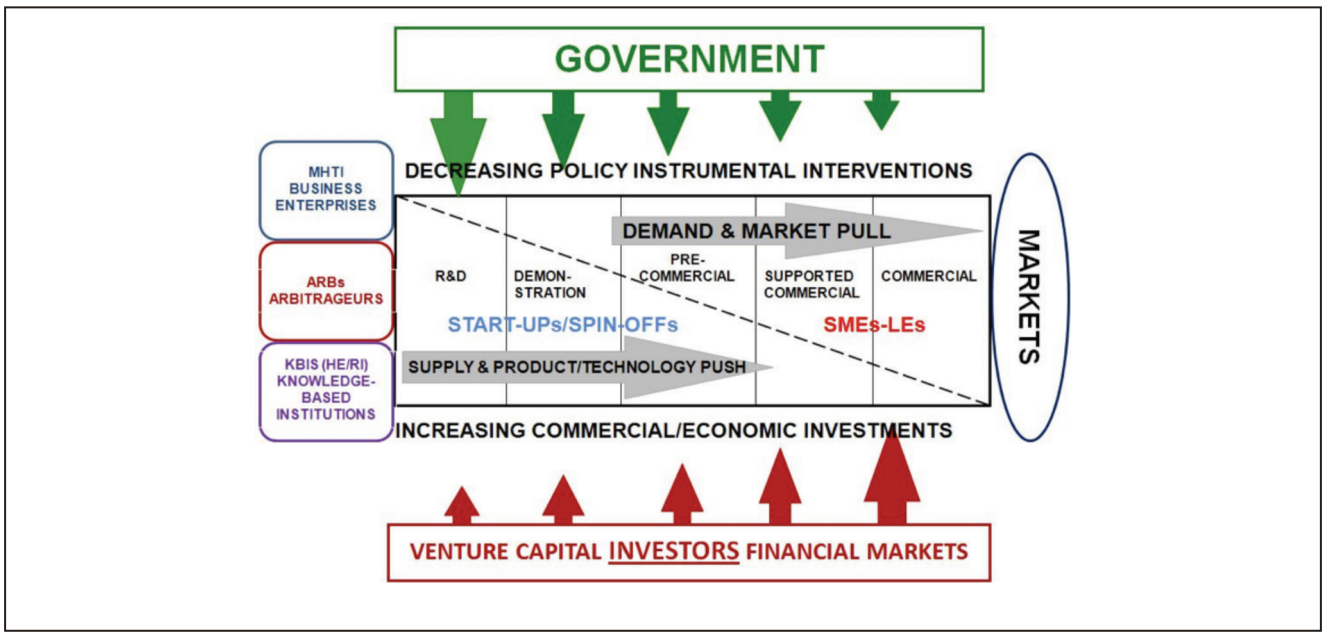
First, the policy recommendations are action oriented and require an implementation schedule that is long-term and realistic, and which commands the consensus of policy-makers at the highest level of the GoK. Such a long-term perspective should be seen in terms of decades. The framework – Policy

policy dimensions from the statistical analysis, the following convention is used: (i) variables are depicted in single quotation marks ('Variable'); (ii) factors in single arrow brackets (<Factor>); and (iii) dimensions in double arrow brackets (<<Dimension>>).

To portray inter-, intra-linkages, the convention used, for example, is as follows:

- Government inter-linkage with Knowledge-Based Institution; proactive inter-linkage i.e. Government to Knowledge-Based Institutions is GOV–KBI, passive inter-linkage (from government perspective) KBI–GOV,
- Government intra-linkage GOV–GOV.

Figure 9.2 *– Policy Stages in the Dynamics of Innovation*



Source: Adapted from Foxon et al., (2004)

Stages in the Dynamics of Innovation (Figure 9.2 below) – provides a means of visualising the interface between public (government) and private (investor) interventions in the dynamics of innovation. Secondly, the innovation policy recommendations should be viewed holistically in terms of relevance (addressing the challenges), coherence (fit-for-purpose, and with each other), and inclusive (concerning Actors). Thirdly, policy instruments arising out of recommendations, and decided on by government, have to be governed effectively and efficiently.

In general, the results from all Respondents (ALL) are reported (unless otherwise stated) and, where appropriate, the results are reinforced by analysis of the individual sets of Actors. Throughout the reporting and discussion of results and implications the terms Respondents and Actors are used interchangeably. Due to 'rounding up', cross-tabulations and particular analytical perspectives, not all summations of figures necessarily total 100%.

To depict and distinguish, within the presentation and discussion, the variables of the survey, the factors and

9.5.1 Research Institutions' Linkages with the Production System and Level of Innovativeness of Business Enterprises

With respect to innovation as a dynamic function of knowledge emerging from research, science and technology, and innovativeness, in the production system of the economy (Gordon, 2012), the role of RIs is paramount[26]. Regarding the linkages between RIs and the production system, as well as the innovativeness of BEs, irrespective of the strength and direction of the linkages between RIs and the production system, 68.2% of ALL KNSI Respondents indicate very low levels of innovativeness of BEs. Only 9.4% of ALL Respondents assess that the linkages are very strong and that there are very high levels of innovativeness of BEs whereas 56.3% assess

[26] A review of U.S. government spending on international S&T collaboration as a way to gain insight into how a developed country spends money on these types of projects: "the United States spends about 50 percent of global funds dedicated to R&D", see Wagner, C.S. Brahmakulam, I. Jackson, B. Wong A. and Yoda, T., (2001). Science and Technology Collaboration: Building Capacity in Developing Countries? Santa Monica: RAND Publications, Science and Technology, p.6.

that the linkages are very weak and there are very low levels of innovativeness of BEs[27].

The policy implications of the disconnect between RIs and the production system, as well as the low levels of innovativeness of BEs are: (i) There are at best few, and at worst no positive externalities arising from the expenditure and public goods in supporting RIs; (ii) The signalling mechanisms by which RIs respond to the market on the one hand, and on the other hand, the production system and BEs make demands on RIs are at best intermittent, and at worst dysfunctional; (iii) The marketing and sales orientation of RIs with respect to their stock of intellectual property is insular and hence inappropriate, and therefore exploitation of their knowledge assets is very limited; (iv) The flows of intellectual property from RIs to the production system are truncated; and, (v) The potential for RIs to earn patent, license and royalty fees from intellectual property rights are largely unrealised.

The policy recommendations relevant to these deficiencies are: (i) Reform of governance in RIs (and by implication KBIs) to enhance excellence in research based on performance measures tied to the funding of RIs and KBIs[28]; (ii) Shift funding of RIs and KBIs to performance-based funding as a function of RIs and KBIs engagement with MHTI in terms of collaborative research, product development, licensing, patent and royalty fees (LPRs), and provision by RIs and KBIs of technological development services to MHTI; (iii) Re-orient the funding of RIs and KBIs toward competitive grants tied to RIs and KBIs – MHTI relationships; (iv) Require RIs and KBIs to create intellectual property rights (IPRs) management offices mandated to patent IP and funded on performance, for example, on in-coming LPRs; (v) Require science, technology, engineering, mathematics and information technology (STEMIT) post-graduate, doctoral and post-doctoral studies competitively funded by government scholarships to be embedded in a MHTI firm[29]; (vi) Selectively condition fiscal and monetary incentives available to MHTI to the hiring of STEMIT post-graduates and embedding of post-graduate, doctoral and post-doctoral studies; (vii) Allow RI and KBI researchers to exploit discoveries commercially through amended contract conditions and career development paths that require such performance; (viii) Increase the management autonomy of RIs and KBIs and the autonomy of their relationships to MHTI; (ix) Require boards of RIs and KBIs to include CEOs from MHTI; (x) Set funding of RIs and KBIs research programmes within a framework of competitive grants based on triangulation (KBI-RI-MHTI consortia) and aimed to increase multidisciplinary R&D; (xi) Create a STEMIT Human Capital Mobility Fund for incentivising the movement of STEMIT personnel from RIs and KBIs to MHTI and *vice versa*; and, (xii) Reform all under-graduate STEMIT curricula to include an industry placement component ('thin' or 'thick' sandwich of three months or six months per academic year, respectively).

Survey Analysis: Extremely Weak linkages between RI and the production system.

Policy Implication: Little if any positive externalities from the public goods of funding RI.

Policy Recommendation: Reconfigure funding of RI to performance-based conditioned by triangulation with KBIs and MHTI.

9.5.2 Importance of KNSI Actor and Strength of Inter-, Intra-Actor Linkages

The relationship between the importance of KNSI Actors and the strength of inter-, intra-Actor linkages is analysed firstly, with the perspective of whether the links are significantly very strong or very weak. Secondly, from an Actor's perspective of the linkages other Actors have between themselves. Thirdly, from each Actor's perspective (Actor centric view) of the linkages it has with other Actors. This is reported both in terms of very important-very strong (VI-VS) and very important-very weak (VI-VW).

The KNSI is analysed in terms of all Actors and individual Actors as Respondents, respectively. This provides insights into whether the Actors have a significant (and convergent or divergent) perception of the NSI variables being examined, the relative distribution (spread of linkages), density (number of linkages) and balance (uni-, bi-directional) of linkages within the KNSI. Each is addressed below.

9.5.2.1 Actor Importance and Government [GOV] [ISTC] Inter-, Intra-Actor Linkages

From the perceptions of ALL Respondents, GOV has no significant inter-, intra-Actor relationship with any other Actor apart from HE which is very strong, as indicated in Figure 9.3

[27] This result is significant at the 99.9% confidence level.

[28] For example ranking of RI and KBIs (institutions and departments therein) on research outputs, publications, patenting, license and royalty fees and funding on a sliding scale of performance-funding. That is, higher performance attracts disproportionately more funding while lower performance is penalised by disproportionately less funding. (See for example UK ESRC research and teaching ranking of UK KBIs, UK ESRC Research Assessment Exercise).

[29] This is in concert with the GoK policy framework for Science, Innovation, Medium Term plan for 2008-2012, 2008 pp.14-15 which emphasise leveraging technology and increasing productivity.

Figure 9.3 *– Government Inter-, Intra-Linkages*

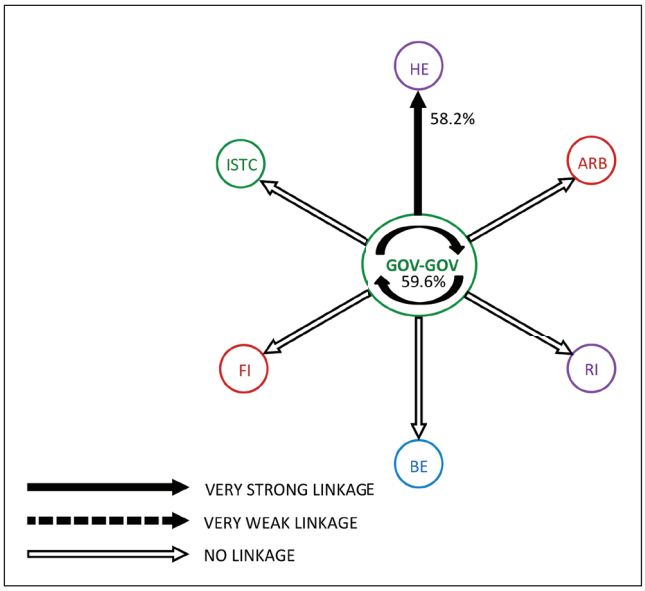


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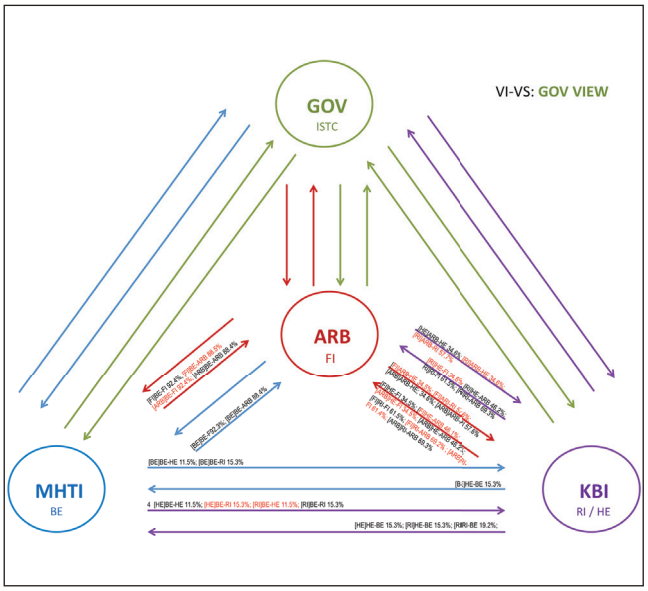
Figure 9.4 *– Government Assessment of Other Actors' Inter-Linkages*



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Figures indicate statistically significant percentage of all Respondents assessing the inter-, intra- linkages. What is striking about Figure 9.3 is that GOV has not even very weak linkages with any other Actor in the KNSI. Apart from the traditional link to Higher Education, government is completely isolated from the KNSI.

From an individual Actor perspective, with respect to GOV-GOV intra-linkages, 52.0% of ARB Respondents perceive GOV-GOV as VI-VW. In contrast 84.5% of GOV Respondents perceive GOV-ISTC as VI-VS[30].

A critical finding, as indicated in Figure 9.4 below, is that GOV Respondents have quite a broad statistically significant perspective of the inter-linkages among other Actors in the KNSI with respect to importance of Actor and strength of linkages. However, the linkages between MHTI-KBI are seen as VI-VS by a minority of GOV Respondents. What immediately stands out is that the relationships that GOV Respondents do not have a statistically significant view on, are the proactive relationships ARB-MHTI and the passive relationship between ARB and MHTI. This is important in that ARBs are crucial in intermediating IPRs and the process of commercialisation and the finding suggests that ARBs are reluctant to engage with BEs or are risk averse with respect to taking equity position in 'spin-offs', IPO, etc. MHTI may well be approaching ARBs but are being rebuffed. Regarding innovation, the isolation of GOV from ARBs disables the GOV from applying incentives for facilitating changes in ARBs behaviour.

The main policy implication of the government isolation from other actors in the KNSI is that the government has at best a truncated view of the key systemic relationships pertinent to innovation in the national economy. This truncated view tends to occlude government policy-makers from the variables of, and priorities in, policy for the overall governance of the NSI in terms of, for example: (i) Coordination of government actions and funding in STI, especially between KBIs and MHTI; (ii) STI organisations' stability (human capital, funding support); (iii) Institutionalising evidence-based policy-making (KNSI Survey applied longitudinally as an advanced assessment, monitoring and evaluation method for managing the NSI); (iv) Evaluation of the mix of policy instruments; and (v) Catalysts for higher networking densities across the KNSI.

The policy recommendations to address the absent inter-linkages of government and government's truncated view of the systemic NSI relationships are: (i) Ministry of Industrialization and Enterprise Development (MoIET) and the Ministry of Education, Science and Technology (MEST) should become superordinated as a Ministry of Innovation, Science, Technology and Industry (MISTI), with the Ministry of Education (ME) as a separate but very closely coordinated ministry. MISTI becomes the primary formulator and coordinator of all KNSI policy and strategy through a statutory inter-ministerial KNSI Policy Unit (KNSIPU), chaired by the two ministers (MISTI and ME) and reporting to cabinet; (ii) The KNSIPU should have oversight of, and responsibility for, NSI policy, planning and funding; and integrating the operations of the three state agencies NACSTI, KENIA and NRF as well as monitoring, evaluation and assessment of Kenya KNSI Actors' performance[31]; (iii) Establish a biennial standing conference – The Innovation Forum Series – (sponsored by

[30] See Annex 1 – Importance of Actor and Strength of intra-Linkages.

[31] The KNSIPU would need to develop research capacity to review best practice in industrialised as well as middle-income countries and emerging markets.

the Government) on 'Innovativeness and Innovation in the National Economy' involving all four Actors in the KNSI[32]; (iv) The KNSIPU should be mandated with setting priorities, defining national and regional policy orientations, and budgetary appropriations concerning innovation regarding its mandate[33]; (v) Require that government innovation policy-making formally and legally consults all KNSI Actors through a 'white' paper and 'green' paper process that involves all four Actors; and, (vi) Establish a legally-binding formal consultative process (six monthly) between the KNSIPU and MHTI (and industry associations), KBIs and ARBs regarding innovation policy.

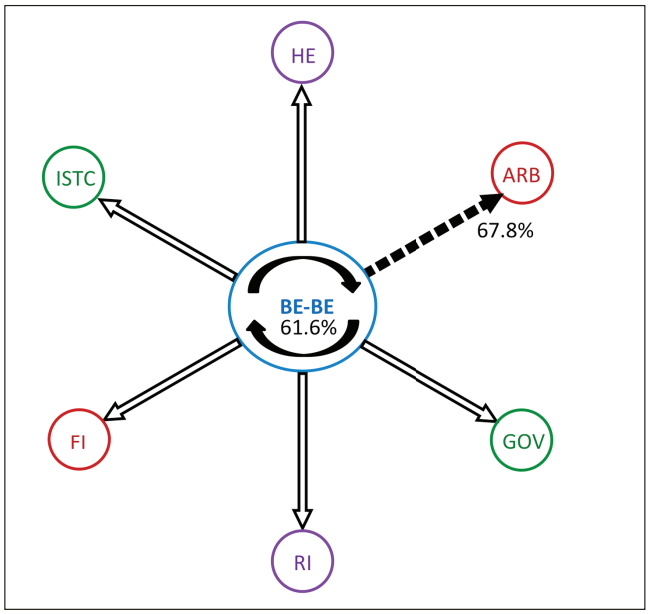
Survey Analysis: Government has absent linkages with other Actors in the KNSI.

Policy Implication: Truncated linkages at best, at worst a myopic view of systemic relationships pertinent to innovation in the national economy.

Policy Recommendation: Create an inter-ministerial KNSI policy unit charged with setting priorities, strategic goals, budgetary appropriations.

9.5.2.2 Actor Importance and Medium and High-Tech Industry [MHTI] [BE] Inter-, Intra-Actor Linkages

Figure 9.5 *– Business Enterprise Inter-, Intra-Linkages*



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[32] From such a conference stakeholder fora will emerge to foster increased innovation policy coherence through strategic goals, business plans and managerial actions. The conference would need to be national at first then add an international aspect after the third conference, in order to 'import' best practices.

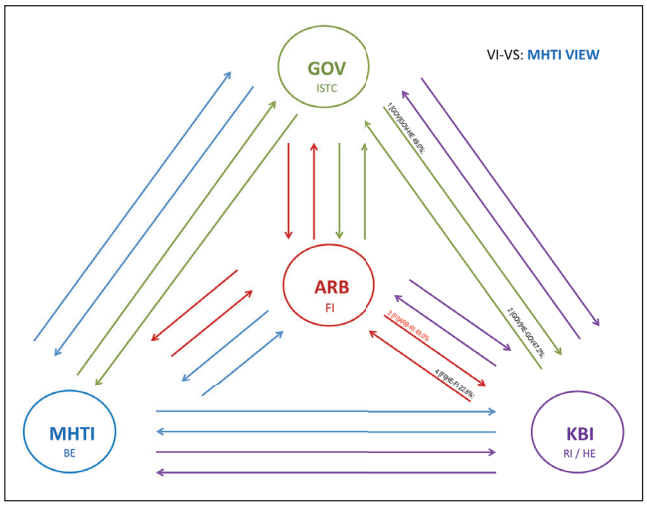
[33] This ensures enhanced policy co-ordination and reduces fragmentary relations between government and KNSI Actors.

From the perceptions of ALL Respondents regarding BE inter-, intra-Actor linkages there is only one significant linkage with ARB and this is perceived as very weak. This is depicted in Figure 9.5. Conversely very strong linkages are found between BE-BE.

From an individual Actor perspective, with respect to BE-BE intra-linkages, 32.0% of MHTI Respondents perceive BE-BE as VI-VW[34].

From the perspective of MHTI Respondents, as indicated in Figure 9.6, the distribution of VI-VS Actor linkages presented is GOV and ARB oriented. While there are significant bi-directional relationships between ARB-KBI and GOV-KBI, interestingly, there is no significant perception of bi-directional linkages between KBI-GOV and KBI-ARB, nor between GOV-ARB and ARB-GOV.

Figure 9.6 *– Medium and High-Tech Industry Assessment of Other Actors' Inter-Linkages*



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The key policy implication of the isolation of Business Enterprises from other KNSI Actors is that industry in general, and MHTI in particular, is at best poorly able to, and at worst powerless to, influence the design, direction, calibration, articulation and disposition of the mix of policy instruments (in time and space) for promoting and accelerating business research and development and institutional innovation. Specifically, Business Enterprises are remote from: (i) An influential role in setting public procurement policy; (ii) Encouraging cooperation and collaboration between KNSI Actors, especially between ARBs, ISTC and industry associations; (iii) Prominence in the overall governance of the KNSI (strategic disposition, orientation and policy priorities); (iv) Projecting to the GoK the factor constraints to innovation that they confront; (v) Reviews and adjustment of regulatory regimes (including performance requirements and standards

[34] See Annex 1 – Importance of Actor and Strength of intra-Linkages.

setting) that govern the relationship between public resources and the private sector with respect to innovation; (vi) Enabling the removal of obstacles and impediments to public private-sector partnerships for innovation initiatives; (vii) Being fully convergent with GoK priorities with respect to demand-signals, as well as fostering human capital mobility from Business Enterprise to GOV (and from GOV to Business Enterprise) to enhance cross-sector collaboration (notwithstanding the need to moderate potential conflicts of interest); and, (viii) Participating fully in the national industrialisation policy as the key driver to lead in contributing to GDP growth.

The policy recommendations to address the implications of the largely absent Business Enterprise inter-linkages with other KNSI Actors, and KBI bi-directional relationships (from MHTI view) are, in concert with earlier recommendations: (i) Condition the management of indirect and direct support to Business Enterprise and MHTI (fiscal and monetary incentives, matching funds, subsidised loans and grants, regulatory and standards setting interventions) and financial sector support (guarantees and venture capital) to Business Enterprise engagement with other KNSI Actors especially KBIs[35]; (ii) Institutionalise the role of Business Enterprise associations and councils in the policy governance of the KNSI through legal and formal consultative processes (including 'white' and 'green' papers); (iii) Reconfigure ICT-based public procurement policy to require pre-qualification to tender based on MHTI inter-linkages with other Actors, especially RIs and KBIs; (iv) Recalibrate industrial strategic sector support to require formal collaborative arrangements between MHTI and public sectors, and KBIs and ARBs, under terms and conditions of matching resources from MHTI companies, RIs and regional government[36]; (v) Incentivise Industry Associations and Chambers of Commerce to create liaison offices that deal in a triangulated manner with KBIs, ARBs and GOV; and, (vi) Incentivise the mobility of personnel between private and public sectors by opening up the STEMIT Human Capital Mobility Fund to SMEs in MHTI.

Survey Analysis: Business Enterprises isolated from other KNSI Actors.

Policy Implication: Business Enterprise (MHTI) isolation leaves them far removed from the policy making process, particularly articulation and calibration of policy to industry needs.

Policy Recommendation: Condition the indirect and direct support to industry on engagement of MHTI with other KNSI Actors especially KBIs and RIs.

[35] In terms of MHTI–KBI indicators such as contracts, R&D projects, collaboration in product development, etc.

[36] In terms of knowledge transfers between the private and public sectors.

9.5.2.3 Actor Importance and Knowledge-Based Institutions [KBIs] [HE] [RI] Inter- Intra-Actor Linkages

From the perceptions of ALL Respondents, HE and RI inter-, intra-Actor linkages (See Figures 9.7 and 9.8) in the majority of cases there are no significant linkages with other Actors. The exception is HE-GOV which is very strong, and RI-HE and RI-ARB which are very weak.

Figure 9.7 *– Higher Education Inter- Intra-Linkages*

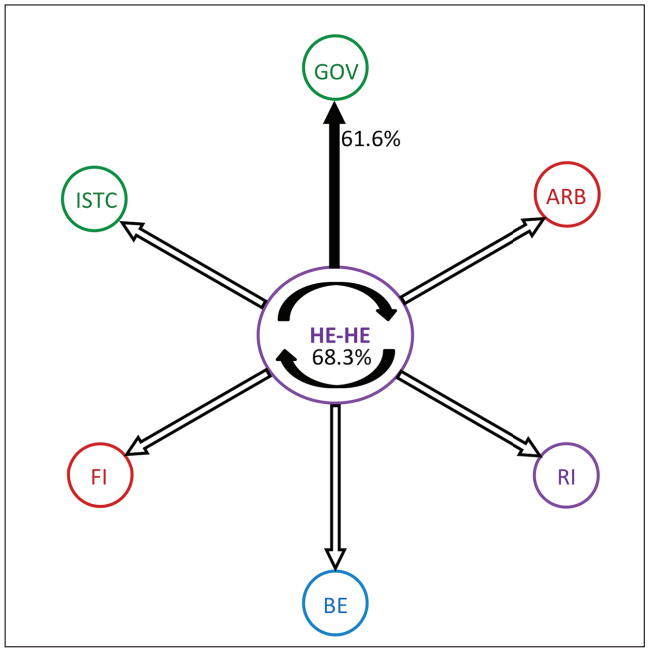

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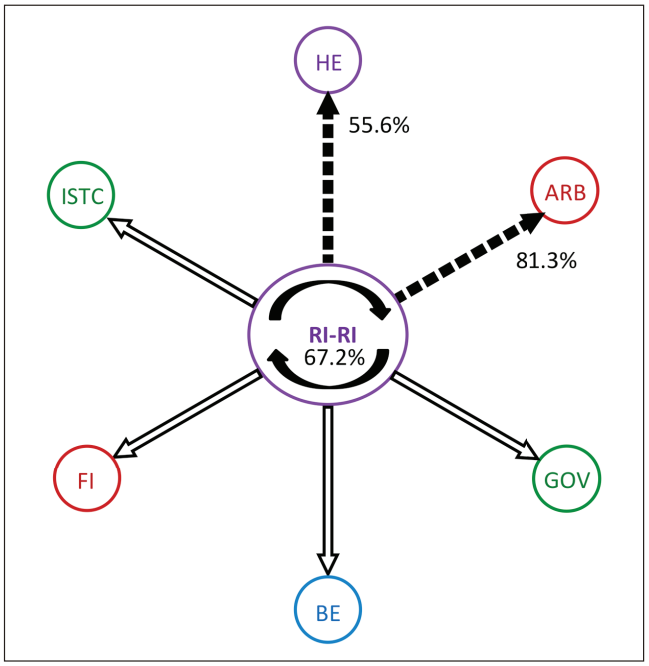
Figure 9.8 *– Research Institute Inter- Intra-Linkages*



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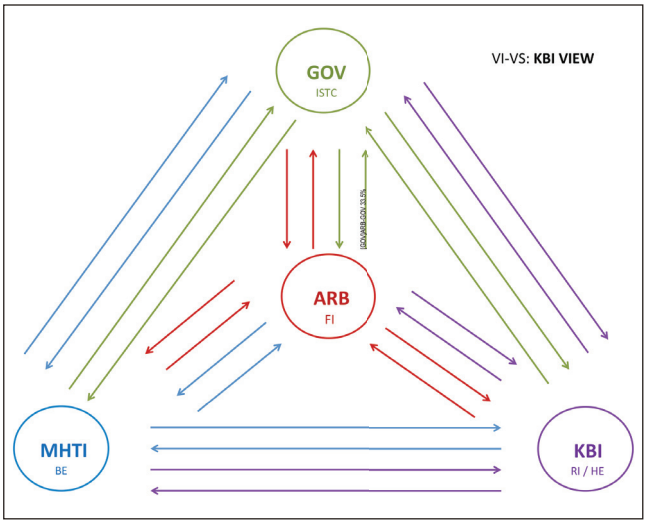
From an individual Actor perspective, with respect to HE-HE intra-linkages, 92.3% of GOV Respondents perceive HE-HE as VI-VS. Contrastingly 76.0% of ARB Respondents perceive HE-HE as VI-VW. With respect to RI-RI, 68.4% of KBI Respondents perceive intra-linkages as VI-VS. Additionally, 59.1% and 54.8% of KBI Respondents perceive HE-RI and RI-HE intra-linkages as VI-VS[37], respectively.

From the perspective of KBI Respondents, indicated in Figure 9.9 below, the only single significant relationship presented is a unidirectional passive relationship between ARB-GOV. Interestingly, there is no significant perception of MHTI or ARB relationships or those between GOV-MHTI by KBIs.

***Figure 9.9** – Knowledge-Based Institution Assessment of Other Actors' Inter-Linkages*



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The key policy implications of the extreme isolation Knowledge-Based Institutions are that firstly, KBIs at best are poorly able, and at worst unable, to tap into and exploit the internal and external stocks and flows of knowledge. Secondly, their intermediation role in the relationships between MHTI and GOV is severely limited with respect to Institutions Supporting Technical Change (ISTC) (leading to their reduced ability to influence innovation policy). KBIs need to be redefined as entrepreneurial with mandates to provide STI solutions to the challenges that Kenya faces[38].

Specifically, Knowledge-Based Institutions (HE, RI) are occluded in terms of: (i) Participation in the research and development networks of KNSI Actors; (ii) Managing the supply-side of advanced human capital resources, and Data, Information, Statistics and Knowledge (DISK) to MHTI in keeping with industry needs; (iii) Responding effectively to the demand-side of human resource requirements from MHTI; (iv) Priorities in specialisation (from other Actor perspectives); (v) Inter-HE and RIs institutional competitiveness; (vi) Pedagogic and curricula programme developments that serve other Actors, especially MHTI; (vii) Alignment of competitive enhancement of Knowledge-Based Institutions with regional development priorities; (viii) Strategic development of Knowledge-Based Institutions' own capacities and capabilities, (ix) Gaining significant benefits from outreach programmes; and, (x) Exploiting their IPRs for LPRs, spin-offs and raising funds.

The policy recommendations to address the absent and perforated very weak Knowledge-Based Institution inter-linkages are, in concert with those for RI: (i) Eliminate regulations and contractual obligations that prevent Knowledge-Based Institution personnel (STEMIT researchers) from participating in industry R&D; (ii) Use the STEMIT Human Capital Mobility Fund to incentivise movement of Knowledge-Based Institution personnel to government policy organs, MHTI and ARBs, and *vice versa*; (iii) Require Knowledge-Based Institutions to hold annual 'open' days with MHTI and ARBs involvement where the results of competitively assessed R&D from HEs and RIs, and STEMIT undergraduate, post-graduate, doctoral and post-doctoral project/studies are displayed for the purposes of generating IPRs; patent, license and royalty fees through collaborative product development and commercialisation; (iv) Require Knowledge-Based Institutions in concert to host a biennial Standing Conference on 'the role Knowledge-Based Institutions in innovation' involving MHTI, ARBs and GOV; (v) Move sequentially away from block grants toward competitive funding for Knowledge-Based Institutions based on performance criteria related to their engagement with MHTI and other KNSI Actors[39]; (vi) Require Knowledge-Based Institution STEMIT departments in collaboration to conduct technology foresight exercises with MHTI, ARBs and GOV[40]; (vii) Evaluate Knowledge-Based Institution performance for R&D 'top up' grants on the basis of triangulation, STEMIT inter-departmental collaboration and academic–industry co-operation indicators; (viii) Require Knowledge-Based Institutions to create, alongside IPR offices, MHTI liaison offices to intensify academic–industry networking; (ix) Require Knowledge-Based Institution STEMIT curricula redesign to meet market demand to include formal consultative process involving MHTI, in order to attract government funding; (x) Reform the academic human resources policy for recruitment to enable MHTI practitioners and executives to teach in STEMIT programmes, and permit sabbaticals in MHTI by STEMIT academics; (xi) Require STEMIT researchers receiving government support to be embedded in MHTI for 50% of the R&D duration; and (xii) Require STEMIT academic promotions to be based on productive links with MHTI.

[37] See Annex 1 – Importance of Actor and Strength of intra-Linkages

[38] A good example of this type of activity is the University of Nairobi Enterprises and Services (UNES). UNES Consultancy is mandated to harness expertise and resources of the University of Nairobi and channel them in a commercial direction. The Unit draws consultants from the large pool of expertise among University staff and associate consultants from the private sector most of whom are alumni of the University of Nairobi. See OECD (2012) and Etzkowitz (2013).

[39] Such as IPRs returns, collaborative R&D, collaborative publishing, commercialisation indicators.

[40] This has the effect of catalysing networking across the KNSI, and deepening and thickening relationships to assist in creating and/or enhancing coalitions that advocate change.

Survey Analysis: Only traditional relationships present (RI-HE, HE-GOV), all other relationships are very weak or non-existent.

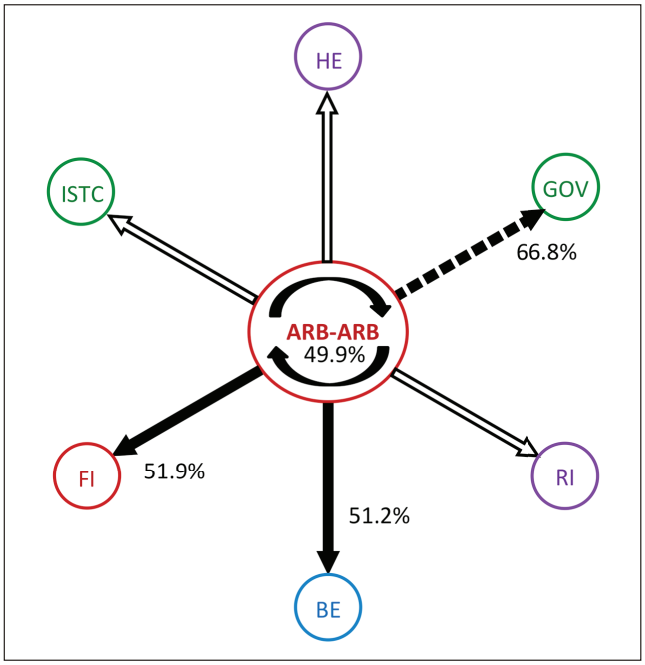
Policy Implication: Knowledge–Based Institutions, at best poorly connected, and at worst unable to tap into, and exploit, stocks and flows of knowledge.

Policy Recommendation: Incentivise the mobility of STEMIT academics to MHTI, and GOV, and use performance-based funding to accelerate KBI performance.

9.5.2.4 Actor Importance and Arbitrageur [ARB] [FI] Inter-, Intra-Actor Linkages

From the perceptions of ALL Respondents regarding ARB inter-, intra-Actor linkages, as seen in Figure 9.10 below, the relationship between ARB-FI and ARB-BE are very strong, and the relationship between ARB-GOV is very weak. Contrastingly, there are no significant relationships between ARB-ISTC, ARB-HE and ARB-RI.

Figure 9.10 *– Arbitrageur Inter- Intra-Linkages*



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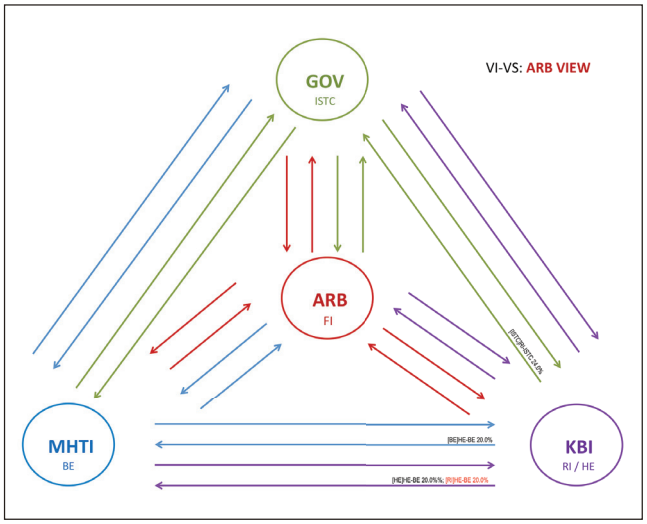
From an individual Actor perspective, with respect to ARB-ARB intra-linkages, 53.9%, and 61.6% of GOV Respondents perceive ARB-ARB and ARB-FI as VI-VS[41].

From the perspective of ARB Respondents, as indicated in Figure 9.11 below, regarding the distribution of VI-VS Actor linkages the only significant relationships are unidirectional. These are KBI-MHTI (proactive), MHTI-KBI and KBI-GOV (both passive). Importantly, there is no significant perception of MHTI-GOV, GOV-MHTI inter-linkages.

The key policy implication is that Arbitrageurs, as the pivotal category of intermediary institutions in the KNSI, are at best performing poorly and at worst not executing their intermediation role as knowledge brokers and venture capitalists at the early stages of ideation, start-up and spin-offs. Specifically, Arbitrageurs are: (i) Isolated from ISTC and KBI (HE, RIs) – the primary sources of DISK – and are therefore severely limited in their intermediation; (ii) Debilitated in their role of linking RIs, HE and ISTC to BEs *via* private equity financing; (iii) Occluded from increasing the technological capacity of BEs through knowledge brokering; (iv) Unable to influence significantly strongly the GoK policies that configure the role of arbitrageurs in the innovation landscape of Kenya with respect to IPR within the national industrialisation policy; and, (v) Limited in their support in realising the goals of Vision 2030 in terms of intermediating national, as well as international, sources of knowledge within an effective and efficient NSI.

Figure 9.11 *– Arbitrageur Assessment of Other Actors' Inter-Linkages*



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Policy recommendations to address the isolation of Arbitrageurs from other Actors in the KNSI, notwithstanding the size of the capital and financial industry in Kenya[42], are to: (i) Condition indirect and direct support to the capital and financial industry on Arbitrageur engagement with MHTI, KBIs and ISTC; (ii) Use direct support measures (subsidised loans and grants) to match venture capital, private equity investments in KBI 'spin-offs' and incubator projects; (iii) Recalibrate the tax code to permit private equity and venture-

[41] See Annex 1 – Importance of Actor and Strength of intra-Linkages.

[42] All the more reason to ensure the active participation of Arbitrageurs in the KNSI.

capital investments in KBI and MHTI R&D activities to be written off against profits; (iv) Require participation of capital and financial industry associations in the formal consultative processes related to KNSI and innovation policy; and, (v) Incentivise the intermediation role of arbitrageurs by reducing the conditions for establishing investment funds.

Survey Analysis: Arbitrageurs are isolated from other Actors.

Policy Implication: Arbitrageurs are severely limited in their role in intermediation.

Policy Recommendation: Incentivise Arbitrageurs to triangulate with KBIs and MHTI

9.5.3 Importance of KNSI Actor and Strength of Actor-Centric Linkages

The following section maps KNSI Actor's assessment of their own inter-linkages and is presented as bullet points for ease of reading. The policy implications are presented thereafter, followed by the policy recommendations at the end of the section.

- It is to be recalled that while 84.5% of GOV Respondents indicate GOV-ISTC as VI-VS, and GOV Respondents have significant assessment of other Actors' inter-linkages (see Figure 9.4); the MHTI view is notable for the absence of significant relationships GOV-ARB, ARB-GOV, KBI-ARB and KBIs–GOV (see Figure 9.6); KBIs do not have a significant assessment of any actor inter-linkages except that of GOV-ARB (passive) (see Figure 9.9); and ARB do not have a significant assessment of KBIs–GOV, MHTI–GOV, GOV-MHTI inter-linkages (see Figure 9.11).
- There is no significant perception by MHTI either of KBI-GOV or GOV-ARB, ARB-GOV, KBI-ARB relations, however mapping the Actor centric data regarding Actor importance and linkages, that is, the Actors' perceptions of its own relationships (see Figure 9.12 below), the majority of KBI perceive VI-VS relationships between KBI-GOV and GOV-KBI with the exception of GOV-HE linkages (only 16.3% KBI assess this as VI-VS). MHTI perceives no significant inter-linkages between KBI-GOV, GOV-KBI but a minority sees significant inter-linkages between ARB-BE. Clearly these two views of MHTI and KBI are asymmetric.
- The Actor assessment of their self (VI-VS) inter-linkages (Figure 9.12) portrays firstly a KNSI that is asymmetrically oriented to, or biased in favour of, the GOV-KBI / KBI-GOV axis with limited ARB participation. Secondly, the axes MHTI-KBI / KBI-MHTI, MHTI-GOV, ARB-MHTI, are significantly missing. Thirdly, ARB-Centric inter-linkages are passive.

The policy implications are: (i) There is insufficient information exchange between MHTI, GOV and KBIs with respect to KBI-GOV relations, which raises the policy question of whether there is a MHTI/KBI forum/standing conference that could help address and facilitate information exchange; (ii) ARBs are isolated from the DISK functions of the KNSI and play no significant active role in terms of intermediating knowledge transfers through modalities such as the financial, or venture capital, frame-working of IPRs, and licensing regarding the IPRs either emanating from KBI, or between KBI and MHTI; (iii) The ARB intra-linkages, perceived as VI-VS by Respondents (49.9%), have very few (if any) significant externalities. It should be noted that from an Actor-centric view, ARBs indicate no proactive linkages with respect to GOV, KBIs and MHTI, and in the minority express passive inter-linkage [GOV]GOV-ARB (40.0%), [ARB]RI-ARB (16.0%), [ARB]HE-FI (20.0%).

- With respect to MHTI perception of the relationships, there are no significant relations (ARB-GOV, GOV-ARB, KBI-ARB, KBI-GOV). The minority of MHTI perceive VI-VS inter-linkages (ARB-KBI, GOV-KBI) (see Figure 9.6 above).

The policy implications of this asymmetry in Actor inter-linkages concern the absence of: (i) Reciprocating relations of communications, coordination and exchange functions formalised through, for example, well-functioning standing committees and conferences; and, (ii) Operative high-performance councils on Science, Engineering Technology and Innovation, economic and social research, and the 'knowledge brokering' role of ARBs (FI)[43].

- With respect to the Actor-centric view regarding VI-VS inter-linkages (see Figure 9.12 below), there are no significant relations between MHTI-KBI, KBI-MHTI, MHTI-GOV, ARB-MHTI. Thus the MHTI-KBI, KBI-MHTI and MHTI-GOV axes are missing from the quadrilateral Actor relationships.

The key policy implication is that the isolation of KBI from MHTI (and *vice versa*), and MHTI from GOV, as well as (passive) asymmetries in the ARB inter-linkages, implies, at best, very limited intermediary roles in the creation of stocks of DISK, and as pumps for flows of DISK through the KNSI. At worst, ARBs have no functional intermediation role in the transfer of DISK between KBI and MHTI. Specifically: (i) The absence of significant (proactive) linkages ARB-KBI, KBI-ARB, ARB-MHTI, and MHTI-ARB means that ARBs do not have open access to DISK created by, and held within, KBI. Therefore, ARBs are prevented from adding value to the DISK by acting as conduits (framed by financial operations) to MHTI or investing directly in KBI hosted incubators or spin-offs; (ii) The [BE]ARB-BE linkage has less depth to it than otherwise in the absence of proactive ARB access to DISK from KBI; (iii) The [GOV]ARB-GOV linkage is likely to be devoid of the practicability of ARBs being able to persuade convincingly GOV towards policies that enhance the stocks and flows of knowledge in, and through, the KNSI (i.e. from KBI to MHTI directly, or indirectly, *via* ARB, e.g. through advocacy and lobbying pressure); (iv)

[43] This is in-spite of the existence of NACSTI, KENIA and NRF.

KBIs are not engaging sufficiently with MHTI with respect to communication of R&D; and, (v) MHTI is disabled from influencing GoK policies regarding STI.

- Notwithstanding the overall weakness of inter-linkages among Actors in the KNSI from a triangular perspective the relationship GOV-ARB-KBI the densest of this relationship is along the axis KBI-GOV. This reflects the traditional role of GOV in funding KBI (HE, RI) (see Figure 9.12 below).

The policy implications of this public goods provision by GOV, in the context of the isolation of KBI from MHTI and ARBs from the KNSI, and hence their insubstantial intermediating role and significant VI-VW systemic inter-linkages, are: (i) Very low returns from the expenditure in treasury, organisational effort and transaction costs[44]; and, (ii) The externalities – the fundamental reason for providing the public goods – are seriously limited thus reducing considerably the effectiveness and efficiency of the KNSI.

Policy implications of the asymmetry depicted by Figure 9.12 below regarding inter-linkages have profound consequences. These policy implications are: (i) The GOV framework of incentives for KBIs (fiscal, monetary, regulatory, standards and performance requirements) is likely to be ineffective in that GOV either tends not to demand KBI-MHTI engagement, or does not enforce such engagement in return for providing financial support to KBIs (and students) in STEMIT; (ii) GOV support to KBI is largely ineffective in the absence of other linkages for example (with respect to [ISTC] ARB-ISTC, 73.1% of GOV Respondents indicate it is VI-VW; [ARB]RI-ARB 72.0% of ARB deem it VI-VW; [ARB] ARB-HE 59.2% of KBI deem it VI-VW); (iii) The performance required from KBIs by GOV is limited at best, and at worst has no dimensions that encourage KBIs to engage proactively with other KNSI Actors through modalities such as rankings of STEMIT departments and faculties, conditioning financial support (concessionary loans, research grants, etc.) on output performance (journal publications, trademarks and patents filed and awarded, license fees and royalties received and paid, IPRs commercialised through incubators and 'spin offs' or through MHTI, and establishing IPRs offices in KBI to engage with MHTI, etc.); (iv) Need for across the board recalibration of STEMIT under- and post-graduate courses to the needs of MHTI by integrating intra-mural course work with extra-mural (MHTI Embedded) industrial work experience facilitated by GOV supported biennial exhibition of KBI IPRs to MHTI; (v) Reconfiguring the national service programme relevantly toward internships in MHTI for STEMIT students; (vi) Conditioning financial support (research and 'top up' grants, etc.) on joint research with MHTI; (vii) Redesigning final year undergraduate and postgraduate projects in STEMIT to be inter-disciplinary involving a minimum of three, and maximum of six, students to address a specific local problem in the vicinity (e.g. building water sanitation, drainage, waste recycling, or building a localised electricity network using solar technology etc.) in order to seed, and initiate, the potential for graduates to create their own employment; (viii) The absent and VI-VW inter-linkages (GOV-ARB, HE-FI, RI-ARB, BE-GOV, ARB-ISTC) between intermediating actors and other actors in the KNSI[45] means that the KNSI is at best limited in its communicative, cooperative and coordination functions and at worst unable to cohere the transmission of DISK throughout the system; and (ix) The missing MHTI-GOV, MHTI-KBI inter-linkages severely limit the absolute levels of innovativeness and throttle the rate of innovation in the economy.

- Whereas the majority (57.9%-60.9%) of KBI Respondents perceive KBI-GOV (bidirectional) as VI-VS, only a minority (26.9%) of GOV Respondents perceive the crucial [ISTC] BE-ISTC linkage as VI-VS) (see Figure 9.12 below).

The policy implications of this VI-VW inter-linkage between BE-ISTC include: (i) Truncated relations with markets, and shortfalls in MHTI in the commercialisation of KBI's IPRs, especially in the light of the absence of significant MHTI-KBI, MHTI(BE)-GOV(ISTC), MHTI(BE)-KBI(RI) inter-linkages; (ii) The absent KBI ([HE]BE-HE) inter-linkages exacerbate the inability of ARB to proactively intermediate; (iii) From a stocks and flows perspective, the stocks of KBI IPRs find little or no receptive outlets in MHTI, and hence there is little or no flow of intellectual property and knowledge within the KNSI; and, (iv) As with GOV performance requirements from KBI, that from MHTI, RI and ISTC is also very limited.

- MHTI see a significant bi-directional relationship between GOV and KBI, but none with respect to KBI-GOV (see Figure 9.6 above). GOV Respondents mirror this view; while KBI Respondents do have a view of KBI-GOV inter-linkages (see Figure 9.12 below). This divergence between MHTI and GOV with respect to KBI-GOV, on the one hand; and asymmetry between MHTI and KBI with respect to KBI-GOV inter-linkages on the other hand is indicative of discordance within the KNSI and its pre-adolescent stage of evolution in terms of the Triple Helix type 4 of GOV-KBI-MHTI-ARB transactional and transformational linkages, (see Figure 9.12 below).

Policy implications from the policy analysis, and of the Actor-centric view, of the Triple Helix type 4 relations include: (i) Conspicuous gaps in MHTI-KBI, MHTI-ARB, MHTI-GOV and ARB-KBI (and *vice versa)* linkages. This has severe consequences for the operation of policy for Science, Engineering, Technology and Innovation through the five levels and means of policy enforcement – communications, co-operation(s), co-ordination(s), command and control (*via* legislation, incentives, regulation, standards, performance requirements and sanction); (ii) Noting that MHTI, KBI and ARB Respondents have few (compared to GOV) significant assessment of inter-linkages among other Actors in the KNSI, it would appear that the policy levers available to GOV are, at

[44] % GDP spent on R&D – South Africa 0.9, Ghana 0.2, Kenya 0.4, Tanzania 0.4, Botswana 0.5. Sources: The World Bank, (2012). World Development Indicators. Research and Development Expenditure % of GDP, 2005-2007. Washington D.C: The World Bank (Research and Development Expenditure % on GDP, 2005-2007).

[45] 13 out of 38 inter-linkages are deemed by a majority of responses to be VI-VW.

best, configured insufficiently well with respect to the other Actors, and at worst remote for effective policy direction and efficient policy craft; (iii) However, the absence of Actor-centric proactive ARB-KBI (*vice versa*), ARB-MHTI (*vice versa*), GOV-MHTI (*vice versa*) and KBI-MHTI (*vice versa*) inter-linkages implies limited ability on the part of GOV to enforce policy (and hence behaviour regarding innovativeness) with respect to KBI-MHTI, ARB-KBI and ARB-MHTI inter-linkages (see Figure 9.12 below), and specifically to MHTI regarding the targeting of early adopters and early majority in the diffusion of innovation.

In summary, the policy implications of the gaps, imbalances and skewness identified in the KNSI from the preceding section may be grouped into: (i) DISK asymmetries; (ii) Limited positive externalities; (iii) Glacial flows of DISK in the KNSI; (iv) An ineffectual framework of incentives; (v) Poorly calibrated and inappropriately configured policy instruments; (vi) Relative isolation of Actors; and, (vii) Relational asymmetries.

Figure 9.12 *– Actor-Centric Assessment of Inter Linkages (Very Important- Very Strong)*

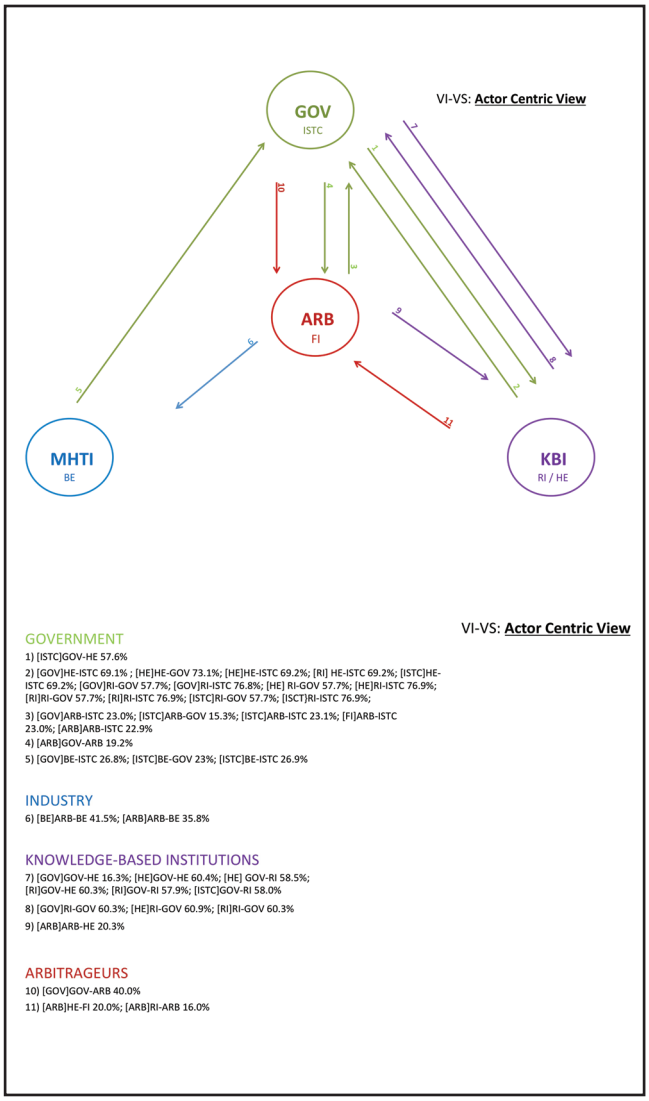

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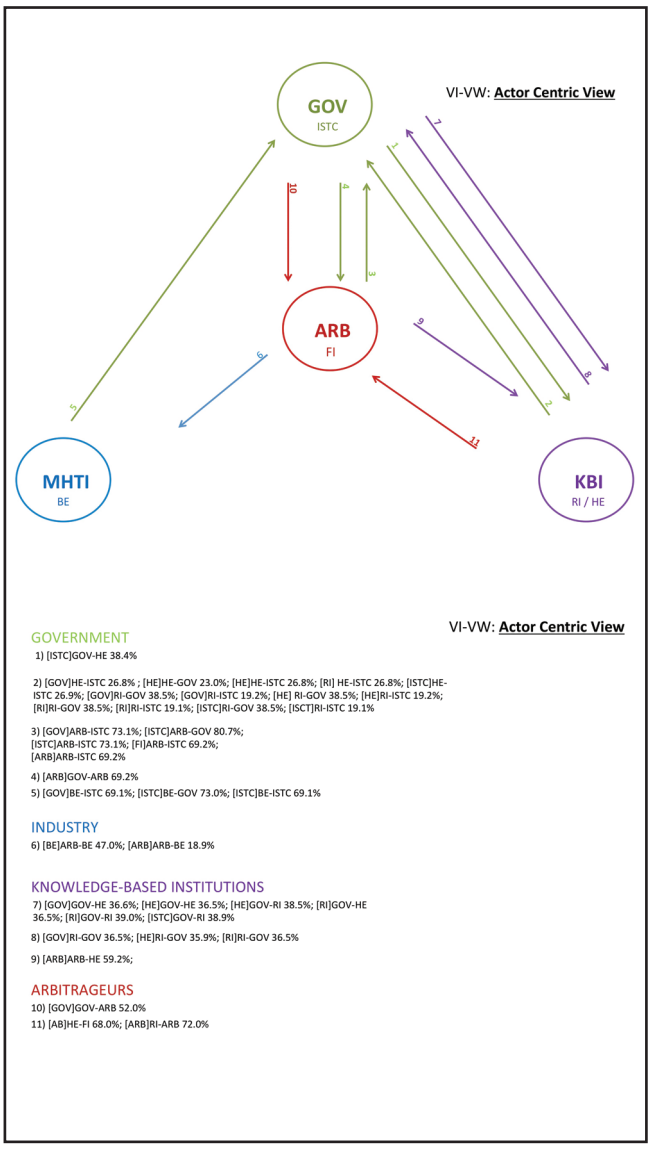
Figure 9.13 *– Actor Centric Assessment of Inter Linkages (Very Important- Very Weak)*



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- Figures 9.12 and 9.13 above provide a map and measure of the statistically significant Actor-centric assessment of their inter-linkages with other Actors (i.e. how one Actor views its inter-linkages with another Actor) in proactive, that is, for example, from the perspective of GOV, (GOV-KBI) or passive, that is, for example (KBI-GOV), along the dimension importance of Actor and strength of Actor-Actor inter-linkages measured as VI-VS and VI-VW. The diagrams require viewing in tandem. The two figures demonstrate clearly the gaps, imbalance and skewness of the KNSI in terms of the correlation of actor importance and actor inter-linkages. They indicate firstly that in regional terms crucial inter-linkages between GOV, MHTI, ARB, and KBI are entirely missing. Secondly, the connections that are significant are assessed as VI-VW by 39.1% of GOV assessments; and by 100% of ARB assessments.

- The first diagram (see Figure 9.12) mapping and measuring the dimension VI-VS shows that firstly, along the axis GOV-KBI there is a majority of GOV Respondents' assessment that their proactive GOV-KBI and passive KBI-GOV inter-linkages are VI-VS. Secondly, along the axis KBI-GOV there is a majority of KBI Respondents' assessment that their proactive KBI-GOV and passive GOV-KBI inter-linkages are VI-VS with the exception of [GOV] GOV-HE (16.3%). All other assessments that are statistically significant indicate VI-VW bi-directional (proactive and passive) inter-linkages.

The policy implications of this statistically significant asymmetrical assessment of the correlation Actor importance and Actor inter-linkages, biased to GOV-KBI, KBI-GOV include: (i) A KNSI that is seriously deficient along the axes KBI-MHTI (*vice versa*), GOV-MHTI (*vice versa*), ARB-KBI (*vice versa*), MHTI-ARB (*vice versa*); (ii) This deficiency is compounded by the isolation of GOV, MHTI, KBI and relative isolation of ARB, absence of MHTI-ARB, MHTI-KBI and ARB-KBI, inter-linkages; (iii) The inter-Actor dialogue on innovation and innovation policy is therefore far from complete with respect to KBI-MHTI (*vice versa*) MHTI-GOV, ARB-GOV, MHTI-ARB (*vice versa*) and ARB-KBI (*vice versa*) inter-linkages; (iv) The lateral side of the Triple Helix type 4 (KBI-MHTI and GOV-MHTI) on which industrial innovation *via* IPRs and innovation policy should be manifest is missing; and, (v) The side on which financial intermediation pumps creative ideas and DISK to, and facilitates IP commercialisation in, markets is also largely missing.

The policy recommendations to address these gaps, asymmetries, defects and deficiencies are; (i) Initiate a formal consultative process on innovativeness and innovation in the national economy[46] involving GOV, MHTI, KBIs, and ARB using, Standing Conferences as well as 'white' and 'green' paper protocols; (ii) Ensure recruitment and accountability standards, managerial requirements and governance structures are harmonised, and linked to performance requirements, across KBIs (RI, HE); (iii) Eliminate constraints preventing public-sector institutions from engaging in STEMIT activities with the private sector; (iv) Adopt common performance agreements (linked to funding), that have external triangular relationship indicators, across KBIs (RI, HE); (v) Increase economies of scale and scope by dissolving poor performance RI, merging middling-performance RI and selectively corporatising high-performance RI[47]; (vi) Create a Science, Engineering, Technology, and Innovation Research Council (SETIRC) chaired at vice-presidential level to signal seniority to re-strategise the mandates, purpose and functioning of national agencies and research institutes with respect to innovation policy and innovativeness in the national economy ; (vii) Adopt an 'open to all' KBI Information Reporting System on STEMIT which is centralised and posts information on research (grants, topics and achievements), curricular developments, graduates (output, enrolment and employment and salary rates per discipline), full-time faculty rates, and scholarships; (viii) Adopt advanced monitoring and evaluation practices for evidence-based assessment of KBIs and policy instruments to address the disconnects between KBI, MHTI and ARB on the one hand, and incentives and performance on the other hand; (ix) Accelerate the strategy for e-Government[48]; (x) Perform an audit of the policy mix of instruments and incentives aimed at increasing innovativeness[49]; (xi) Reconfigure public sector procurement policy, terms and conditions to require triangulation between MHTI, KBI and ARB[50]; (xii) Use regional development funds to triangulate regional government, industry associations and KBIs for developing clusters[51]; (xiii) Ensure MHTI, KBIs and ARB representation on the SETIRC (Chambers of Commerce and University Councils); (xiv) Adapt the Foreign Direct Investment (FDI) regulatory regime to adjust its modal neutrality[52] to favour business collaboration and R&D joint ventures between foreign investors, MHTI and KBIs; and, (xv) Adapt the tax code to favour venture capital investments in the KBI IPRs.

Survey Analysis: Absent or asymmetric inter-linkages between KNSI Actors.

Policy Implication: Nexus of industrial innovation and innovation policy largely absent from the KNSI.

Policy Recommendation: Establish an overarching SETIRC to re-strategise the mandates, purpose and functioning of national agencies and institutes dealing with STEMIT.

[46] The KNSIPU and SETIRC would have to work closely together. SETIRC would need to set out the strategic short,-medium-and long-term themes for innovativeness in the national economy such as; agricultural productivity; information technology; material science; etc., arrived at through foresight exercises executed by KBIs. KNSIPU would need to facilitate the necessary co-ordination to achieve goals.

[47] It is strongly recommended that the SETIRC has the overarching responsibility and oversight regarding innovation and NACSTI, KENIA and NRF. The reorganization of RIs would have to be executed with a timeframe to allow market absorption and retraining of retrenched personnel, asset disposal etc. to minimize disruptive forces compromising the efficiency drive.

[48] Quantitative targets.

[49] The use of the KNSI longitudinal policy mapping instrument in order to measure convergence or divergence in terms of policy outcomes.

[50] Such conditionalities tend to thicken the triangular relationship through the requirement of a R&D component as well as a venture capital component to make public procurement innovation oriented.

[51] KBIs foresight exercises will assist in identifying such.

[52] Modal neutrality refers to policies designed to allow investors to decide for themselves how best to service the markets they enter.

9.5.4 Strength of Inter-, Intra-Actor Linkages and Level of Innovativeness of Business Enterprises

Regarding the linkages and the level of innovativeness, the articulation and configuration of the Triple Helix type 4 Actors are crucial in terms of system robustness, symmetry and reciprocating exchanges of value in the KNSI. The analytical mapping and measuring that follows examines the strength of KNSI Actors' inter-, intra-linkages in relation to the level of innovativeness of Business Enterprises in order to disclose the predominant patterns and the implications the dispositions carry.

9.5.4.1 Government [GOV] [ISTC] Inter-, Intra-Linkages – Level of Innovativeness of Business Enterprises

- Bearing in mind that GOV as a key (policy and resources) Actor in the KNSI has, or should have, high density, well distributed and balanced (bi-directional) links with other Actors in the system, regardless of the strengths (or weaknesses) of GOV inter- and intra-linkages 66.0%-74.6% of ALL Respondents indicate very low level of innovativeness of BEs[53].
- Notably only 7.1%-22.0% of ALL Respondents assess that GOV inter- and intra-linkages are very strong and that there are very high level of innovativeness of BEs[54]. Although an encouraging range of 17.8% to 39.9% of ALL Respondents indicate very strong GOV inter- and intra-linkages, however, these same Respondents also indicate that there is very low level of innovativeness of BEs.
- More noticeably, a range between 28.4% and 56.8% of ALL Respondents indicates that GOV inter- and intra-linkages are very weak and there is a very low level of innovativeness of BEs[55].
- With respect to the crucial GOV-BE linkages 67.5% of ALL Respondents indicate very low levels of innovativeness in BEs and only 12.6% indicate VS-VHI in BE, in contrast to 51.1% who indicate VW-VLI.
- Surprisingly, GOV Respondents do not have a statistically significant view of GOV's own inter-, intra-linkages and level of innovativeness of BEs. This finding is salient, in comparison with other Actors' assessment of GoK linkages, and highly notable as it suggests that GOV has no significant assessment of other Actors' inter-, intra-linkages (see figure 9.14). This is despite GoK Respondents assessments of other Actors' inter-linkages (see Figure 9.4 above)[56].
- Also surprisingly, GOV Respondents do not have a statistically significant assessment of BEs linkages and the level of innovativeness of BEs.

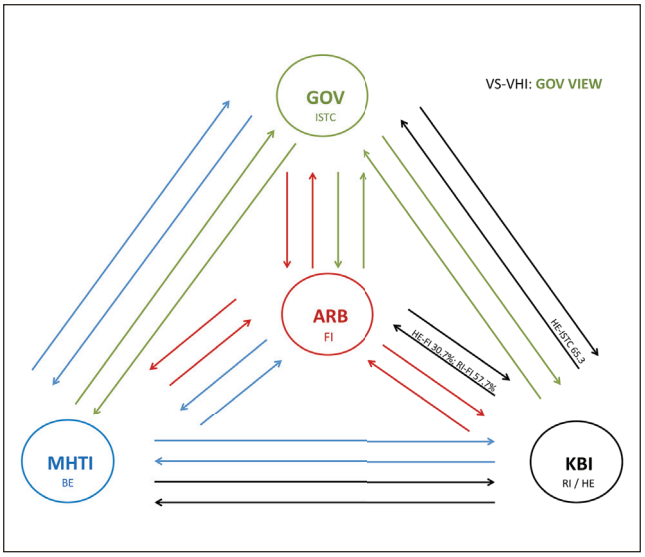
[53] This result is significant at the 90.0% confidence level and above.

[54] This result is significant at the 90.0% confidence level.

[55] This result is significant at the 90.0% confidence level

[56] From a test-retest perspective of DASI reliability and validity this lack of significant assessment of linkages strength and level of BEs innovativeness may suggest that, given GOV isolation (see Figure 9.3 above), the findings in Figure 9.4 above indicate what GOV Respondents think 'should be' rather than 'what is'. It needs recalling that the linkages MHTI-KBI (*vice versa*) are deemed VI-VS significantly by a minority of GOV Respondents (11.5%-19.2%). This linkage is crucial to innovativeness in BEs (Science Business Innovation Board, 2012).

***Figure 9.14** – Government View of Linkages and Level of Innovativeness – VS-VHI*



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The policy implications are: (i) The Government not having readily at hand the full means and instruments to map and measure the KNSI for policy assessment, monitoring, evaluation and adjustment despite extant policy documents on STI, and in spite of GoK perceptions on other Actors' linkages (see Figure 9.4); (ii) The extent to which government is, itself, isolated from the KNSI (see Figure 9.3), regarding government inter-linkages which are deemed very strong only with HE (a traditional link) and non-existent with all other Actors as assessed by ALL Respondents presents a serious challenge to government efforts in creating a higher performance NSI even if significant funding becomes available in the near future[57]; (iii) Government not having means at hand to map and measure the level of innovativeness systemically in the national economy[58]. This is confirmed by Kenya's rankings in the Global Information Technology Report 2014 (World Economic Forum, 2014, p.168), in which the range of positions of Kenya in various categories of the networked readiness index (crucial to stocks and flows of DISK) related to ICT and NSI, is 55th to 113th out of 148 countries. At the finer granular level of scrutiny, this performance regarding ICT and networked readiness shows a range of positions of 66th to 125th out of 148 countries. While the affordability of ICT may rank Kenya relatively competitive at 21st for prepaid mobile tariffs, it is ranked less competitively at 119th for broadband Internet tariffs, and in terms of connectivity, these neither produce sufficient externalities that translate into advantages for the KNSI[59], nor generate directly innovativeness in BE;

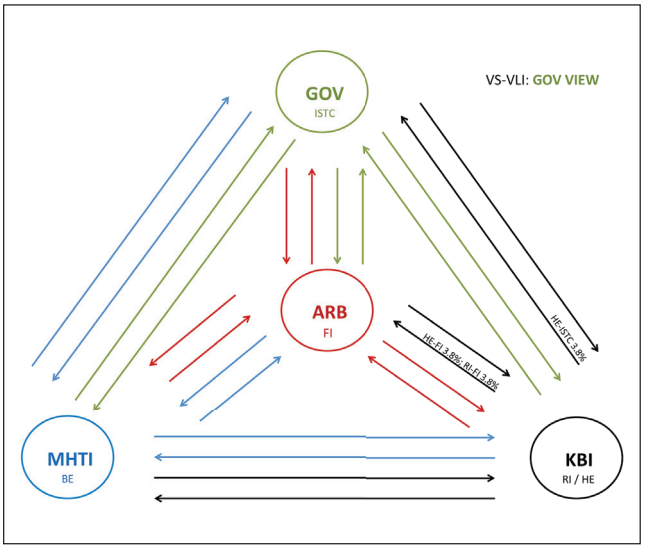
[57] Hydrocarbons exploration activities in Kenya show considerable promise of substantial reserves (Tullow oil discovers 'high quality' oil in Kenya, Reddan F., (2014). Kenya to become an oil producer by 2017, editor, Business Day, 16 July 2014, businessdayonline.com

[58] Notwithstanding the availability of indicators such as those found in: i) AU-NEPAD (2010), African Innovation Outlook; and ii) The World Bank (2012), World Development Indicators.

[59] This is likely because in terms of ICT individual usage Kenya ranks 81st to 128th out of 148 countries even though business usage ranks 34th to 93rd, and government usage ranks 31st to 86th.

(iv) The Government's ability to manage the conflictual/co-operative balance between Actors, institutions and organisations regarding competition for resources in favour of co-operation is at best tentative, and at worst doubtful; (v) Innovation policy coordination is also subject to higher levels of uncertainty than would be otherwise without the availability of comprehensive 'road maps' of the KNSI; (vi) Achieving convergence in innovativeness with competitor countries is likely to be extremely difficult; (vii) The Government's ability to orchestrate the strategic coherence of the KNSI is vague; and, (viii) The Government tends to perceive its role as limited to a distributor of resources.

***Figure 9.15** – Government View of Linkages and Level of Innovativeness – VS-VLI*



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- Notably, GOV Respondents have neither a significant assessment of linkages between BE-GOV and a very low level of innovativeness of BE, nor that of ARB-ISTC. However, GOV Respondents do have a statistically significant view on KBI-GOV (HE-ISTC) linkages with 65.3% of Respondents indicating VS-VHI in contrast to 19.1% indicating VW-VLI.
- More than 62.4% of MHTI, 75.5% of KBI, and 60.0% of ARB Respondents indicate very low level of innovativeness of BE regardless of the strengths (or weaknesses) government linkages, respectively[60].
- Interestingly, while All Respondents, MHTI, KBIs and ARBs in the minority assess linkages and level of innovativeness as VS-VHI, GOV Respondents are more optimistic[61].
- 18.9%-22.7% of MHTI Respondents view GOV linkages with other actors (and itself) as VS-VLI. In contrast, 39.7%-45.3% view GOV linkages as VW-VLI. 12.1% to 48.1% of KBI indicate that GOV linkages with other Actors (and itself) as VS-VLI, while 29.2% to 65.8% of KBIs indicate GOV linkages as VW-VLI. 24.0% - 48.8% of ARB indicate that GOV linkages with itself (ISTC) as VS-VLI, while 20.0% to 36.0% indicate view GOV linkages as VW-VLI.

The key policy implications group into: (i) Lack of well-calibrated instrumentation to monitor the level and rate of innovativeness; (ii) Under-leveraged legislative power; (iii) Muted policy dialogue; and, (iv) Competitive divergence below that of potential frontier EMEs.

Specifically, the high statistically significant assessment of very low levels of innovativeness, irrespective of the strengths of government inter-linkages implies that: (i) The Government command over the environment for innovation is insufficiently accomplished to foster rapidly, through policy incentives, regulation and performance requirements, economy-wide levels of innovativeness by other KNSI Actors; (ii) The Government may be under-leveraging its legislative power with respect to increasing the level of higher-resolution standards in the provision of goods and services; (iii) The policy environment may be insufficiently configured by the Government to encourage higher levels of innovativeness systemically; (iv) The role of government, as the prime driver of the economy[62], is not fully utilised in encouraging innovativeness and innovation among early adopters and early majority in the diffusion of innovation paradigm, through government procurement requirements, legislation and regulation; (v) The very weak government linkages at best mutes, and at worst disables, the policy dialogue between KNSI Actors; and, (vi) GOV-BE (and *vice versa*) links are neither resulting in high innovation, nor is government contributing significantly to the innovativeness of BEs[63].

The policy recommendations to address these long-term threats to the KNSI are: (i) The SETIRC along with the KNSIPU to strategise and prioritise a KBI-MHTI centred innovation system by legislatively allocating 2% of GDP for public expenditure support to the science and technology sector[64], which can leverage private sector efforts; (ii) Ensure that the public sector science and technology base (represented by RIs) is not divorced from MHTI R&D by requiring KBIs (RIs) to instigate formal and regular fora of dialogue on R&D agendas with MHTI, and Industry Associations and involving Government [65]; (iii) Adoption of the methodology for surveying NSI for longitudinal monitoring, assessment and evaluation of the KNSI regarding policy

[60] This result is significant at the 95.0% confidence level.

[61] GOV Respondents assess the VS-VHI more positively than other Respondents by a factor of two or three.

[62] It is to be recognised that in the OECD countries, over the long-term, GOV is directly responsible for between 20% to 65% of respective GDP (1995). Nowadays it is 30% to 55% (OECD, 2005).

[63] Note that 64.2% of MHTI Respondents assess the level of innovativeness as VLI, and 45.3% assess BE-GOV linkage as VW-VLI.

[64] According to the World Bank (2012 database) expenditure on R&D amounted to 0.98% of GDP for Kenya in 2012 (Latest figure available). According to the Legatum Institute (2013) R&D expenditure is 0.5% of GDP (2011) which is below the global average of 0.8%.

[65] Such activity should then become the criteria for assessing the performance of KBIs (RIs).

implementation, as well as measuring the 'fitness' of KNSI Actors with a view to applying incentives to improve fitness; and, (iv) The KNSIPU to streamline the regulatory environment for STEMIT by auditing regulations to identify and remove burdensome legislation, and to propose new regulations that accelerate innovativeness and innovation in the economy[66].

Survey Analysis: Very weak inter- intra-BE linkages and low level of BE innovativeness.

Policy Implication: Innovation is primarily manifest in industry (supply-side) and markets (demand-side), however BE isolation means little access to other sources of knowledge.

Policy Recommendation: Address barriers to innovation and initiate a Promising Local Companies in MHTI programme.

9.5.4.2 Business Enterprises [MHTI] Inter-, Intra-Linkages – Level of Innovativeness of Business Enterprises

- Regarding BE intra-, inter-linkages and the level of innovativeness of BE, 61.9%-68.6% of ALL Respondents indicate very low innovativeness in BE irrespective of the strengths of BE intra-, inter-linkages. In stark contrast, only 8.9%-25.0% of ALL Actors indicate very strong BE linkages with other Actors and very high level of innovativeness of BE.
- Notably, GOV Respondents do not have a significant assessment of linkages between BE and other Actors and level of innovativeness in BE (see Figure 9.15 above). This is contrasted by MHTI Respondents, of which only 20.8% indicate very strong linkages between BE-GOV and a very high level of innovativeness in BE.
- 18.9%-34.0% of MHTI Respondents view BE linkages as VS-VLI. 13.3%-32.9% of KBI Respondents indicate that BE linkages as VS-VLI, while 45.0%-64.5% indicate view BE linkages as VW-VLI.
- While 23.2% of ALL Respondents gauge BE-GOV as VS-VLI, with reference to industry only 18.9% of MHTI Respondents perceive BE-GOV as VS-VLI. 13.3% of KBI Respondents assess BE-ISTC as VS-VLI.
- Notably, 64.5% and 60.8% of KBI Respondents evaluate respectively BE-ISTC and BE-ARB as VW-VLI.
- 77.9% of KBIs Assess the KNSI as having very low level of innovativeness irrespective of the strength of BEs linkages. Furthermore, KBIs assess the BE-ISTC, BE-FI, BE-ARB as VW-VLI respectively at 64.5%, 45.0% and 60.8%.

[66] For example legislation that provides special treatment (accounting, fiscal) for R&D goods and services that are sourced in response to public procurement tenders.

Figure 9.16 *– Medium and High-Tech Industry View of Linkages and Level of Innovativeness – VS-VHI)*

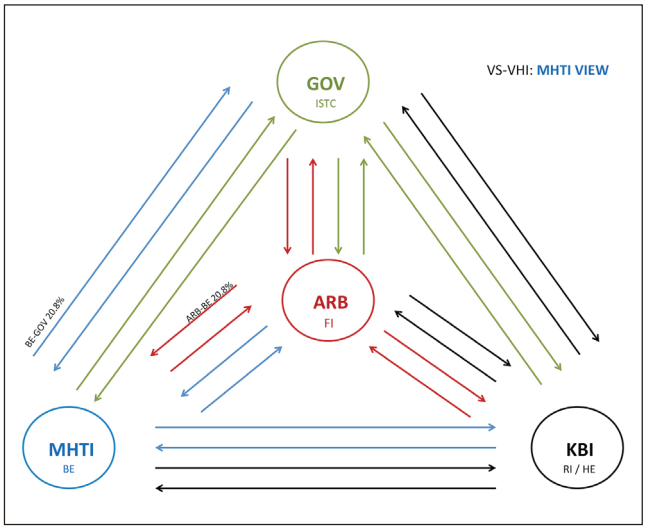

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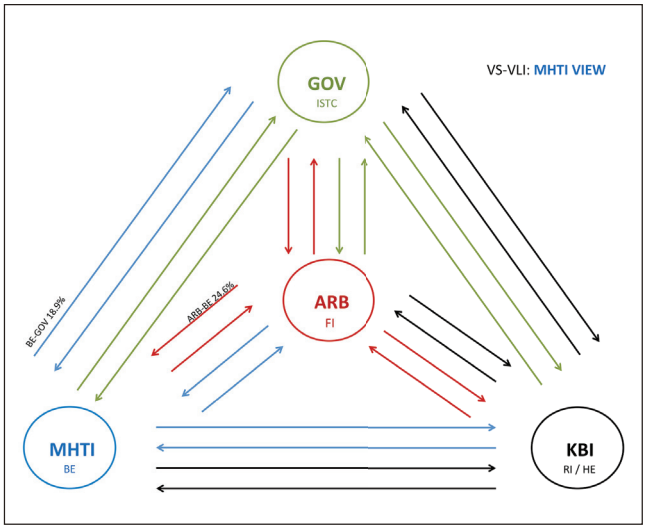
Figure 9.17 *– Medium and High-Tech Industry View of Linkages and Level of Innovativeness – VS-VLI)*



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Policy implications of overall VW-VLI regarding Business Enterprise inter- and intra-linkages and very low level of innovativeness in Business Enterprise are of serious concern as innovation is manifest mostly in industries (supply-side) and markets (demand-side). Policy implications include: (i) Given Business Enterprise almost total isolation from other Actors in the KNSI, especially from Government and KBIs, MHTI has little, if any, access to sources of innovation other than its own research and development expenditure and efforts[67]; (ii) Reciprocating relations with KBIs are also limited and therefore the exposure of Business Enterprises to DISK is severely reduced; (iii) The VW-VLI deficiency should be

viewed through the lens of government's limited and uneven command over the environment for innovativeness and innovation, which in turn implies that the performance and regulatory dynamic for increasing standards and competition is lethargic; (iv) Opportunities to leverage and synergise Business Enterprise R&D with that in RIs are severely limited, despite extant government incentives to Business Enterprises and grants to KBIs and RIs; (v) The identification of 'promising local companies' and potential 'national champions' is obscured; (vi) Market signals with respect to demand are likely to be largely unnoticed; (vii) Opportunities for generating externalities through cross-cutting licensing and patenting, and concomitant fees are limited; and, (viii) the role of ISTC is stymied.

The policy recommendations to address the very weak Business Enterprise linkages and very low level of Business Enterprise innovativeness are: (i) Consider preferential tax rate for MHTI as a function of triangular (MHTI-KBIs-ARB) R&D, joint product development, sub-contracting relations; (ii) Address the barriers to innovation specifically identified by MHTI; (iii) Initiate under the SETIRC a programme of identifying SMEs that are 'promising local companies' in MHTI and assisting them to grow[68]; (iv) Initiate under the SETIRC a 'commercialisation and marketing framework' in tandem with the promising local companies programme that incubates spin-offs and SMEs in MHTI from the triangulation mentioned above; (v) Configure, as part of the Government venture capital system, a Technology Commercialisation Fund (TCF) access to which requires triangulation (MHTI-KBI-ARBs) to enable R&D to become IPRs that can be licensed; and, (vi) Perform an analysis of FDI spillovers to MHTI and adjust the FDI regime to enhance spillovers and externalities[69].

Survey Analysis: Government has an isolated and very limited assessment of other Actor linkages and level of innovativeness within the KNSI.

Policy Implication: Lack of policy mapping of KNSI for policy monitoring and evaluation.

Policy Recommendation: Adoption of methodology for surveying NSI for longitudinal monitoring, assessment and evaluation of the KNSI.

[67] According to the African Innovation Outlook (2010), business enterprise R&D is 2.4% of Gross Domestic Expenditure on Research and Development (GDERD) (US$277.8 Million PPP), and because MHTI is isolated from KBIs the externalities from this resource application are largely unreleased. See AU–NEPAD, (2010). African Innovation Outlook 2010. Pretoria: AU-NEPAD.

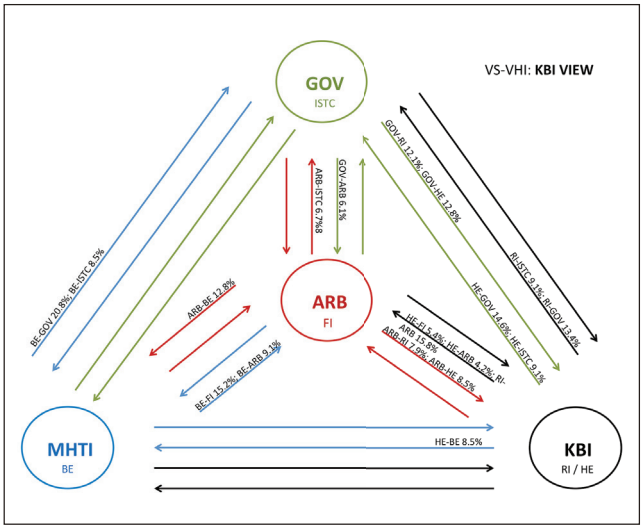
[68] Setting up an agency for SMEs that are promising local companies in MHTI; setting eligibility criteria; developing programme (firm analysis, follow-up by relevant extant agencies, packaging financial, fiscal, incentive schemes) for the firms to grow.

[69] Kenya receives 17.6% of its GERD from external sources (ODA or *via* FDI).

9.5.4.3 Higher Education [KBI] Inter-, Intra-Linkages - Level of Innovativeness of Business Enterprises

- In the case of HE linkages, irrespective of the strengths (or weaknesses) of Higher Education linkages more than 68.0% of ALL Respondents indicate very low levels of innovativeness of BE. Nevertheless, 8.9%-23.4% of Respondents indicate very strong HE inter-, intra-linkages and very high levels of innovativeness of BE[70].
- Specifically, with respect to the key linkages between HE and BE All Respondents do not indicate significant linkage relationship and very low levels of innovativeness of BE.
- This is the same situation with MHTI Respondents. (see Figure 9.16 above).
- Notably, while GOV Respondents in the majority (65.3%) indicate VS-VHI with respect to HE-ISTC this is contrasted by the minority of KBIs (9.1%).
- KBI Respondents assess their own linkages and level of innovativeness as VW-VLI with a range of 29.2%-68.7% [with a majority in all linkages except HE-GOV (a traditional linkage)]; and RI linkages as VW-VLI with a range of 30.4%-52.4%
- In the case of HE inter-linkages specifically with ARB and ISTC, 77.9% of KBI indicate very low levels of innovativeness in BE irrespective of the strength of linkages. With respect to ISTC and ARB only 9.1% and 4.2% of KBI indicate very strong HE inter-linkages with ARB and ISTC, and very high levels of innovativeness of BE (see Figure 9.18 below).

***Figure 9.18** – Knowledge-Based Institution View of Linkages and Level of Innovativeness – VS-VHI)*



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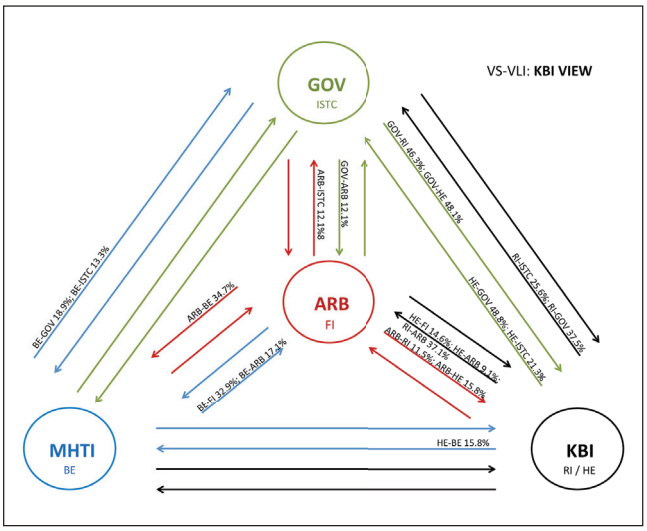
- Notably, with respect to perceptions of KBIs regarding HE-FI, HE-ARB only 5.4% and 4.2% indicate VS-VLI, respectively. With respect to perceptions of KBI regarding ARB-HE, 15.8% indicate VS-VLI in contrast to 62.2% who assess the relationship as VW-VLI (see Figure 9.19).

[70] These results is significant at the 95.0% confidence level.

***Figure 9.19** – Knowledge-Based Institution View of Linkages and Level of Innovativeness – VS-VLI)*



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As with GOV inter-, and intra-linkages and the level of Innovativeness of BE, Higher Education inter-, and intra-linkages assessed as very weak concomitant with very low level of innovativeness of BE has serious policy implications. Specifically, these concern: (i) The very weak Higher Education inter-linkages with ARB, FI, ISTC, BE, which suggest that KBI DISK and IPRs do not have outlets, through intermediation and commercialisation, to demand markets; (ii) KBI (Higher Education and RIs) have relatively poor market intelligence capacity and capability – in other words they do not know with sufficient accuracy what MHTI (BEs) and the market need and, as such, can neither respond to, nor address, those needs through appropriate innovative solutions regarding curricula reformation or R&D; (iii) The management of the KBI IPRs system, such as it is, is likely to be remote from users [MHTI (BEs)] and inter-mediators [ARB (FI)]; (iv) STEMIT curricula redesign with mandatory industrial placements is likely to be hampered; (v) Research is likely to be tangential to the needs of MHTI; (vi) Opportunities for industry funded and sponsored R&D, as well as product development, leading to incubation and spin-offs (in high technology) into SMEs are truncated; (vii) IPR based opportunities for fund raising are limited; (viii) The divergence of assessment of HE linkages and level of innovativeness between GOV, ALL and KBI Respondents (GOV is optimistic, ALL and KBIs are pessimistic) implies a reluctance on the part of the GoK to address deficiencies; (ix) Regarding the HE-ISTC linkage while 65.3% of GOV Respondents assess this as VS-VHI only 9.1% of KBI indicate this, therefore reinforcing the optimistic view of GoK and its tendency not to address concerns urgently; and (x) The convergence of assessment of HE-ARB as VW-VLI by ALL (59.8%), KBIs (68.7%) and RI-ARB as VW-VLI by 52.4% of KBIs indicates the inability of KBI to use ARB as conduits to the market.

The policy recommendations to address the very weak Higher Education linkages and very low levels of innovation are: (i) Adopt a competitively incentivised IPR management system for KBIs that disproportionately rewards KBIs with the highest STEMIT IPR performance (LPRs and industrial contracts); (ii) Reconfigure funding of post-graduate studies to favour disproportionally STEMIT programmes; (iii) Provide incentives (fiscal, monetary, regulatory and performance requirements) for STEMIT post-graduates to work in the private sector[71]; (iv) Redesign STEMIT post-graduates courses and programmes to require mandatory one-year placements in an MHTI (particularly SMEs) firm, where part of the research is performed; (v) Reconfiguration of the public service entrance and promotion examinations system to link to STEMIT, management courses and programmes in KBIs; (vi) Incentivise MHTI to write off against profits industry funded and sponsored R&D that takes place under contract in KBIs; (vii) Reconfigure the mandates, and performance assessment criteria, of ISTC from reactive to proactive engagement with KBIs; and (viii) Recalibrate the fiscal conditions pertaining to ARBs to enable write off against profits, ARB funded equity positions in KBI spin-offs, R&D and commercialisation of KBI IPRs.

Survey Analysis: HE inter- intra-linkages are very weak and the level of innovativeness of BE is very low.

Policy Implication: KBIs have highly restricted outlets through intermediation and commercialisation, to demand markets; poor market intelligence; and are insufficiently aware of market needs.

Policy Recommendation: Incentivise mobility between KBIs and MHTI and fund KBIs on IPRs performance.

9.5.4.4 Research Institutes [KBI] Inter-, Intra-Linkages – Level of Innovativeness of Business Enterprises

- With respect to RI inter-, intra-linkages, 62.5-68.4% of ALL Respondents indicate very low levels of innovativeness of BE irrespective of the strength or weaknesses of linkages [72]. This is reinforced by ARB and KBI of whom more than 60.0% and 67.9-78.0%, respectively, indicate very low levels of innovativeness of BE irrespective of the strength or weakness of RI linkages. In contrast, only 9.4%-19.0% of ALL Respondents and 9.1%-15.8% of KBI Respondents indicate very strong RI linkages and very high levels of innovativeness of BE.
- This is in sharp contrast with the GOV view 22.9% of whom deem very low level of innovativeness of BE irrespective of the strength of the RI-FI linkage. 57.7% of GOV Respondents deem the RI-FI linkage VS-VHI.

[71] Through mechanisms that encourage self-employment by 'two years plus one' funding for STEMIT masters and 'three years plus two' funding for STEMIT doctorates to use their R&D studies to create businesses. Also *via* mechanisms that incentivise MHTI to hire STEMIT post-graduates.

[72] These results are significant above the 99.0% confidence level.

- Notably, an encouraging 25.6%-40.2% of KBIs indicate very strong RI linkages and a very low level of innovativeness of BEs.
- Bearing in mind the absence of strong inter-linkage of RI (Fig. 9.8 above), there is a divergence between GOV and KBI Respondents regarding RI-FI and RI-ARB with 19.1% GOV Respondents assessing as VW-VLI in contrast with 52.4% of KBI Respondents assessing as VW-VLI.
- Only 15.8% of KBIs indicate RI-ARB linkages as VS-VHI, whereas 60.0% of ARBs indicate that RI-ARB linkages as VW-VLI.
- Notably, with respect to the key linkage between RIs and BEs, 68.2% of ALL Actors indicate very low levels of innovativeness of BEs irrespective of the strength of linkages, and only 9.4% indicate very strong linkages and very high levels of innovation of BEs.

The policy implications of VW-VLI with respect to Research Institutes inter-linkages are particularly serious as Research Institutes constitute a key transmission mechanism for DISK in terms of IPRs into best practice and the market place. Policy implications, similar to those concerning HE, but nuanced by what should be the feed role of RIs and Research Institutes' isolation from other KNSI Actors (except with HE and ARB[73]) are: (i) The policy analysis points to at best a distracted and solitary role, and at worst a dysfunctional role, of Research Institutes in the KNSI; (ii) Research Institute (strategic and applied) research and development may be divergent to the needs of MHTI; (iii) Even if Research Institutes DISK transmission mechanisms have potential, the complete isolation of ARB from RIs, ISTC and HE in the KNSI implies truncation as the financial support framework for commercialisation of R&D and DISK is missing to a large extent (see Figures 9.7, 9.8 and 9.12 for the RIs' isolation and missing bi-directional inter-linkages between ARB-KBI (*vice versa*) and ARB-MHTI (*vice versa*)); (iv) An absence of a sales and marketing disposition on the part of Research Institutes with respect to IPRs, BEs and MHTI; (v) As with HE, opportunities for funding, sponsorship and R&D joint ventures with MHTI (intermediated by ARB) are severely limited; (vi) Opportunities for human capital mobility between Research Institutes and MHTI are truncated; (vii) The research agendas of Research Institutes is likely to be divergent from the demands of the market place; and, (viii) The divergent assessment between GOV and KBI Respondents (GOV 57.7% VS-VHI RI-FI; KBI 15.8% VS-VHI RI-ARB) would tend to moderate the urgency with which GoK addresses challenges.

The policy recommendations for overcoming very weak Research Institute inter-linkages and low levels of innovativeness of BE are convergent with those for HE and include: (i) In addition to the national auditing of Research Institutes, submitting Research Institutes to external international review by bodies such as UNIDO, OECD, and South Africa's National Advisory Council on Innovation (NACI) [74]; (ii) Recalibrate Research Institute human resources policy, terms and conditions to enable Research Institute staff to perform their research in MHTI companies in terms of sabbaticals, contracts or under patents, licenses and royalty protocols; (iii) Reconfigure government procurement of services from Research Institutes to require triangulation by Research Institutes (i.e. RI-MHTI-ARB) in the provision of services; and, (iv) Reconfigure government funding support to Research Institutes to be contingent on matching funds to that raised by Research Institutes from MHTI in the form of sponsorships, LPRs, research funds.

Survey Analysis: Isolated or dysfunctional role of RIs in the KNSI.

Policy Implication: Strategic research and development operations misaligned with the needs of MHTI specifically and that of the market in general.

Policy Recommendation: Reconfigure government procurement of services from RI to require triangulation (RIs–MHTI–ARBs).

9.5.4.5 Arbitrageurs Intra-, Inter-Linkages – Level of Innovativeness of Business Enterprises

- Regarding ARB intra-, inter-linkages and level of innovativeness of BEs, irrespective of the strength of linkages, over 63.1-68.3% of ALL Respondents indicate very low level of innovativeness in BEs. In contrast, only 8.9%-19.8% indicate very strong ARB linkages with other Actors and very high level of innovativeness of BEs.
- In contrast, the more optimistic assessment by government Respondents is that 42.3%-46-2%% perceive the ARB Intra-linkages and level of innovativeness of BEs as VS-VHI. This is not reflected by KBIs 16.4% of whom assess the ARB-FI as VS-VHI. Additionally, with respect to KBIs assessment regarding ARB-HE and ARB-RI, respectively, only 8.5 % and 7.9% of KBIs indicate VS-VHI. With respect to KBIs assessment of ARB-HE and ARB-RI linkages, respectively, 62.2% and 66.5% indicate VW-VLI.
- 22.7%-26.4% of MHTI Respondents estimate ARB linkages as VS-VLI. In contrast, 37.8%-41.6% rate the linkages as VW-VLI. 11.5%-36.6% of KBI Respondents indicate ARB linkages as VS-VLI, while 41.4%-66.5% assess the linkages as VW-VLI.
- Interestingly, 65.8% of KBI Respondents assess the ARB-ISTC as VW-VLI[75].
- With respect to ARB linkages, Industry and KBI have a similar pessimistic perspective which differs significantly from the optimistic assessment of GOV.

Policy implications of overall VW-VLI with respect to Arbitrageur inter-, and intra-linkages and level of innovativeness in BE

[73] Both very weak linkages (See Fig 9.8 above).

[74] As well as other competent international private sector organisations skilled in audits.

[75] The result is significant at the 99.9% confidence level.

given Arbitrageur isolation, include: (i) Truncated efforts by Arbitrageurs to intermediate DISK from KBI to MHTI and BE, and therefore stocks of knowledge remain unexposed while any flows are, at best, glacial; (ii) The non-existent GOV-ARB and very weak ARB-GOV inter-linkages indicate limited ability of Arbitrageurs to influence innovation policy with respect to intermediating between KBI and MHTI; (iii) Arbitrageurs are, by and large, unable to exploit the competitive advantages that arise from information asymmetries extant between KBIs and other KNSI Actors to generate positive externalities; (iv) Arbitrageurs are largely cut off from taking equity positions in either potential start-up businesses, based either on KBI R&D outputs or spin-offs from KBI and MHTI; (v) The crucial role of ARB linking the GOV-KBI-MHTI axes of the Triple Helix type 4 is largely missing; (vi) The view of GOV that ARB linkages are VS-VHI suggests that GoK is likely to be reluctant to address issues pertaining to very low levels of innovativeness in an urgent manner; and, (vii) The absence of significant assessment by GOV Respondents on ARB inter-linkages points to a myopic view by GoK of the intermediating roles of ARBs.

The policy recommendations to address the Arbitrageur inter-linkages and very low level of innovativeness are: (i) To decide a strategy for expanding the size, and deepening the 'thickness' of the capital and financial markets in Kenya in terms of number of firms, as well as the availability of Venture Capital[76]; (ii) Condition fiscal and monetary, as well as standards, regulatory and performance incentives to the finance capital industry on the intermediation role of Arbitrageurs, with respect to KBIs and MHTI; (iii) Use Government-Backed Venture Capital to match equity positions by Arbitrageurs in technology incubation programmes in KBIs; (iv) Require future KBI development of science and technology parks to have 'anchor' tenants from finance capital industry; (v) Use the STEMIT Human Capital Mobility Fund to support mobility of personnel in finance capital to teach in KBIs (sabbaticals) with respect to Venture Capital management of R&D, and commercialisation; (vi) Map the structure of early stage financing of innovation and entrepreneurship[77] in Kenya; (vii) Restructure Government-Backed Venture Capital into separate funds relevant to stages of innovation and entrepreneurship to induce the finance capital industry to enhance their intermediation (see Figure 9.2)[78]; (viii) Increase competition in the finance capital industry by adjusting fiscal conditions to enable high net-worth individuals to invest directly in start-ups or in venture capital funds; (ix) Instigate a formal consultative process between GOV, ARBs, KBI, MHTI with respect to reducing barriers to ARB intermediation; and, (x) Consideration to enabling the capital and financial markets in Kenya to launch secondary (less regulated) markets.

- In the case of Actor inter- intra linkages, in the minority ARBs view the few significant linkages as VS-VHI ranging from 16.0% to 24.0%. ARBs have no other view of Actor linkages that are significant and related to very high levels of innovativeness of BEs.
- The scanty view by ARBs of significant Actor linkages and level of innovativeness of BEs is in keeping with the MHTI and GOV view, but is in sharp contrast with the KBI view which find many more significant linkages and level of innovativeness of BEs.
- The relationship RI/HE-ISTC-FI-BE is not found to be significant by ARBs with respect to Actor linkages and the level of innovativeness of BEs.

The policy implications of overall absence of VS-VHI with respect to ARBs include: (i) The void in the triangulation MHTI-ARB-KBI; (ii) The vacuous triangulation MHTI-ARB-GOV; (iii) The consequential voids in the triangulations BE-FI-RI/HE and BE-FI-ISTC; and (iv) Disconnects between ISTC, BEs, FI, and RI/HE (the source of DISK) point to dysfunctionalities in the mandates and roles of institutions supporting technical change in the economy.

The policy recommendations to address the imperfections of truncated and absence of high level of innovativeness in BEs involve: (i) Reconfiguring and recalibrating the mandates and roles of institutions supporting technical change so that they are incentivised to take a proactive stance with respect to engaging with FIs and venture capital on the one hand, and on the other hand, gearing with BE regarding DISK from RI/HE; (ii) Ensuring that incentives applicable to FIs and Venture Capital would need to be audited for 'fit-for-purpose' with respect to encouraging Venture Capital to intermediate more effectively and efficiently between RI/HE and BEs (and *vice versa*); (iii) Ensuring that ARBs are increasingly central to triangulation with BEs and RI/HE through fiscal incentives in terms of gains to FIs and Venture Capital regarding investments in incubation and spin-offs; (iv) Using GOV control over development finance institutions to drive monetary support to BEs to

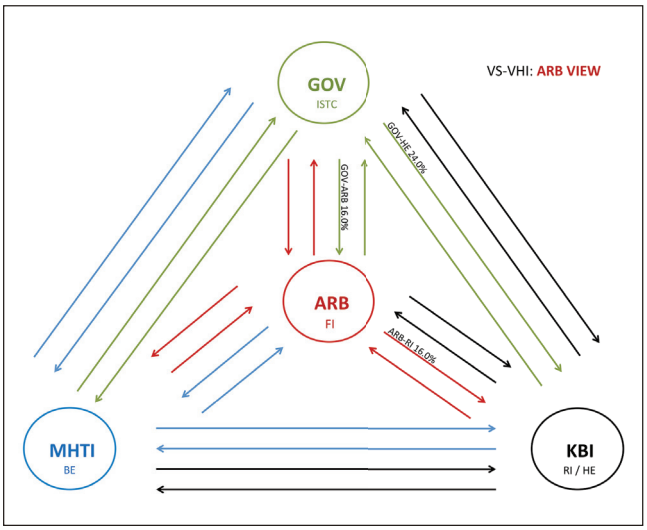
[76] The exemplary Venture Capital Industry (VCI) is that of Israel notably the Yozma programme that created the VCI in Israel. The policy addressed the failures in the process of innovation and entrepreneurship (early stages funding gaps, absent complementary assets and skills). See: Avnimelech, G. and Teubal, M., (2005). Evolutionary Innovation and High Tech Policies: What Can We Learn from the Israel's Targeting of Venture Capital? Science, Technology and Economic Program (SETE), Working Paper Series WP-25-2005. Neaman Institute, Technion-Israel Institute of Technology; Avnimelech, G. and Teubal, M (2004), Venture Capital Start-up Co-evolution and the Emergence and Development of Israel's new high tech cluster, Economics of Innovation and New Technology, 13(1), pp. 31-60; Lerner, J. (2010), The Future of Public Efforts to Boost Entrepreneurship and Venture capital, Journal of Small Business Economics, 35(3), pp. 255-264; Avnimelech, G., Rosillo, A., Teubal, M. (2010), Evolutionary Interpretation of Venture Capital Policy in Israel, Germany, UK and Scotland. Science and Public Policy 37(2), pp. 101-112.

[77] Latent stage (seed capital), early stage ('angel' investors), growth (corporate/private equity).

[78] Empirical evidence suggests strongly that: (i)Government-Backed Venture Capital (GVC) increases the total amount of venture capital; (ii) Enterprises with GVC and private venture capital (PVC) receive more total funding than firms financed purely with PVC; (iii) Firms with GVC and PVC (having more investors) are more successful than those with just GVC or PVC. See Brander *et al*., (2010).

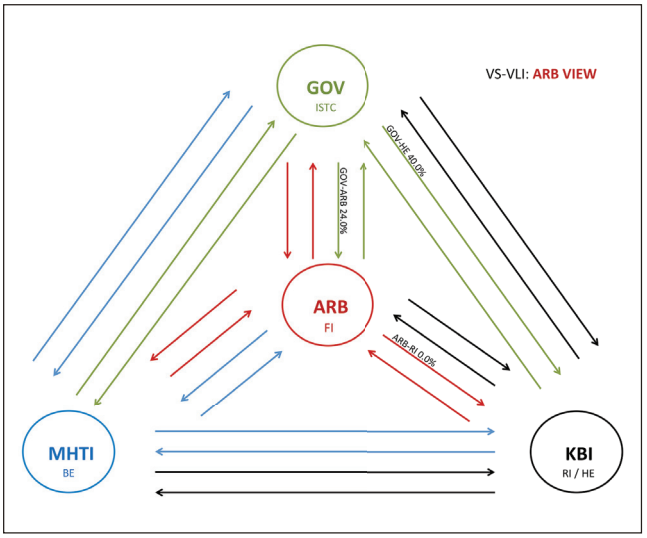
require BEs engaging with RI/HE as well as Venture Capital in investing in incubation and spin-off enterprises housed in KBIs; and (v) Employing standards setting and performance requirements to encourage ARBs to meet performance indications that reflect innovativeness[79].

***Figure 9.20** – Arbitrageur View of Linkages and Level of Innovativeness – VS-VLI)*



For larger image see Annex IV

***Figure 9.21** – Arbitrageur View of Linkages and Level of Innovativeness – VS-VLI)*



For larger image see Annex IV

[79] For example reconfiguring reporting standards to require specific identification of KBI spin-offs.

Survey Analysis: Arbitrageurs (Financial Institutions, Knowledge-Brokers and Venture Capital) are detached from other Actors in the KNSI.

Policy Implication: Stocks of knowledge are unexposed and flows of DISK are glacial at best and non-existent at worst.

Policy Recommendation: Condition incentives to expand and thicken finance capital industry to increase the intermediation role of ARB.

The statistically significant linkages between Actors and the level of innovativeness of BEs indicates clearly that Respondents perceive systematic relationships between the two variables Actor linkages and level of innovativeness in BE. This is critical for policy craft and configuring and calibrating the structure (spatial and temporal) of the system of incentives. The mapping and measurement of KNSI Actor linkages with the production system in the economy, the importance of Actor and strength of inter-, intra-Actor linkages, and strength of linkages and level of innovativeness of BE (from Actor perspective of other Actor's linkages and Actor's own perspective of own linkages with others) shows, in general: (i) Perforated or truncated linkages with the system of production, (ii) Recognition of Actor importance but poorly articulated inter-Actor linkages; (iii) Specifically very low levels of innovativeness and innovation in BE; and (iv) Asymmetries in the quadrilateral relationships between GOV, MHTI, KBIs and ARBs leading to 'blind siding' of policy makers.

We move on to identify and disclose the factors that constitute the barriers to innovation and which are responsible for the perforated, and poorly articulated linkages, as well as the palpable lack of richness in the environment for innovativeness and innovation.

9.5.5 Latent Factors to Barriers to Innovation

Factor analysis (to indicate the underlying factors that significantly influence barriers to, and hence policy instruments for, innovation) enables evidence-based policy design to be targeted specifically and accurately to remove the highest barriers to innovation in prioritised sequencing.

Factor analysis condenses observed variables into factors in a pattern matrix (clusters of inter-correlated variables) with 'mutual interdependence' (Gaur, 1997). The factors represent the underlying structure that is responsible for the variation of variables in the data and thus the population (Kim Jae-On and Mueller 1978). Tables 9.7, 9.8, 9.9, 9.12 and 9.13 indicate the underlying factors of barriers to innovation.

9.5.5.1 Description of Table Structure

The column factor number indicates the descending rank order of the importance of the factor, which influences the sets of barriers to innovation variables. The column factor name provides a description for the grouped variables influenced by the factor, and enables meaningful policy discussion of the barriers to innovation. The factor names are assigned based on the factor loading of the variables taking the higher loading variables into consideration as well as judicious use of empirical evidence and theory in the

literature of NSI. The naming of factors therefore reflects the variables that are most influenced by the underlying factor, and hence there are commonalities and differences regarding Actor responses. The column factor loading indicates the correlation between factors and variables, i.e. the extent to which the factor influences the variable. The column Cronbach's Alpha indicates the internal consistency and reliability of the factor, and hence the cohesion of variables as a group. The dominant heuristic, or commonly accepted, rule of thumb for describing internal consistency and reliability using Cronbach's Alpha, is indicated in Table 9.6 below (George and Mallery, 2003; Kline, 1999; Cortina, 1993).

For the purpose of policy analysis, factors influencing groups of variables with Cronbach's Alpha below 0.7 are deemed inconsistent and unreliable and are rejected for policy purposes. The factors enable economy-wide policy prescriptions, as well as Actor (sector) specific policy prescriptions to be carefully and accurately designed.

The column Total Variance Explained (TVE) indicates the amount of variance (variation) of the groups of variables, in the data sample and population, which is accounted for by the factor. It is an indication of the extent or power of the influence of the factor. The column Kaiser-Meyer-Olkin (KMO) is a measure of sampling adequacy. It indicates the robustness of the sample in terms of distinct and reliable factors extracted. The Bartlett's Test of Sphericity (BTS) indicates the significant confidence level regarding the coherence of factors, reproducibility and generalisability of the results (Kaiser, 1974; Dziuban and Shirkey, 1974, p.359; Kim and Mueller 1978, p.54; Rummel, 1970).

***Table 9.6** – Internal Consistency of Factor*

Cronbach's Alpha	Internal Consistency/Reliability
$a \geq 0.9$	Excellent
$0.9 > a \geq 0.8$	Good
$0.8 > a \geq 0.7$	Acceptable
$0.7 > a \geq 0.6$	Questionable
$0.6 > a \geq 0.5$	Poor
$0.5 > a$	Unacceptable

9.5.5.2 Latent Factors to Barriers to Innovation – ALL

***Table 9.7** – Latent Factors to Barriers to Innovation (ALL)*

Number of Factor	Name of Factor	Variables	Factor Loading	Cronbach's Alpha	Total Variance Explained	KMO	Bartlets Test of Sphericity		
							Chi Square	Df	Significance
1	Uncertainty Avoidance & Risk	Brain Drain	0.796	0.739	31.317	0.832	1748.699	136	0.000
		Organisational Rigidities	0.661						
		Hierarchical Organisations	0.638						
		Excessive Percieved Economic Risk	0.590						
		Innovation Costs (Too High)	0.589						
2	Unsophisticated Markets	Lack of Innovative Customers	0.812	0.795	13.841				
		Lack of Demanding Customers	0.795						
		Lack of Higher Resolution Regulations	0.622						
		Lack of Competition	0.605						
3	Skills Capacity	Lack of Technically Trained Manpower	-0.814	0.838	7.971				
		Quality of Technically Trained Manpower	-0.770						
4	ICT Incapacity/ Incapability	ICT Capacity	-0.793	0.720	5.938				
		Rate of Access to ICT	-0.716						
		Lack of Explicit Policy Support	-0.584	**Cumulative Total**	**59.067**				

NB. Non-Redundant Residuals are computed between observed and reproduced correlations. There are 76 (50.0%) non-redundant residuals with absolute values.

- In the assessment of ALL Respondents Factor 1 <Uncertainty Avoidance & Risk> is the highest most significant barrier to innovation in the KNSI, in which the 'Brain Drain' is the most crucial variable. The Factor 1 is responsible for 63.4% of the variation in the variable 'Brain Drain'.
- Factors 2 <Unsophisticated Markets>, 3 <Skills Capacity>[80] and 4 <ICT Incapacity/Incapability> are also significant barriers to innovation, however Factor 2 explains less than a half of the TVE of Factor 1, and individually Factors 3 and 4 each explains less than a third of the TVE of Factor 1.
- Factor 4 <ICT Incapacity/Incapability> confirms the Triple Helix type 4 configuration of the NSI and indicates the critical importance of ICT talent and the diffuseness of ICT within the system as a conduit for enhancing the stocks and flows of DISK and skills. However, given the perforated, truncated and absent linkages identified, it is clear that the KNSI is far from a well-balanced and integrated Triple Helix type 4 status and concomitant performance.

[80] *Ceteris Paribus*, given the role of cognitive skills in economic development (Hanushek and Woessmann, 2008) there appears a trade-off between capacity of skills and capability in skills with increase in capacity having a decrease in quality of the skills capability (Evans, 2012).

- In Factor 2 <Unsophisticated Markets> we find a consensus with GOV, MHTI Respondents regarding the importance of markets for driving innovation through demanding customers, innovative customers and competition. This factor is consistent with findings in the literature (Bartels *et al*., 2012).

Overall, the key policy implication is that without an appetite for risk taking, supported by a policy environment that influences the behaviour of markets, and threshold levels in skills-ICT capability/capacity, economy-wide innovativeness and innovation is extremely difficult[81]. Specifically policy implications include: (i) In resource constrained circumstances, the crucial choice is where fiscal and monetary incentives, as well as standards, regulation and performance requirements, should be directed to improve the most significant Factor 1 <Uncertainty Avoidance & Risk>, through stemming the 'Brain Drain'[82] and reducing the 'Organisational Rigidities'; (ii) In terms of policy implications (and hence the sequencing of policy implementation through Actor specific business plans and managerial action) the four factors have different temporal characteristics in terms of policy action (but not necessarily policy outcome)[83]; (iii) F1 <Uncertainty Avoidance & Risk> is relatively long term (5-10 years), given the organisational dynamics and need to change institutional behaviour, although short-term action can be taken immediately to stem the 'Brain Drain' by changing the terms and conditions pertinent to knowledge workers and the highly qualified as well as altering the structure of certifying qualifications to incentivise incumbency (without compromising performance); (iv) F2 <Unsophisticated Markets> is medium-term (3-5 years) given the legislative aspect of putting into place higher resolution regulations (and standards); (v) F3 <Skills Capacity> is relatively short-term (1-3 years) at least in terms of curricula redesign at tertiary level[84]; (vi) F4 <ICT Incapacity/Incapability> is relatively short term (1-3 years) given the infrastructure aspect of laying down ICT Capacity; and, (vi) All factors are important and have to be addressed by government policy on innovation.

The aforementioned implications invoke a policy orientation that: (i) In a resource constrained environment, where hard choices and trade-offs must be made, the sequencing of policy targets should be in the rank order (first to last). The 'Brain Drain' and 'Innovation Costs (Too High)' variables in F1 <Uncertainty Avoidance & Risk>[85], F4 <ICT Incapacity/Incapability>, F3 <Skills Capacity>, F2 <Unsophisticated Markets>; (ii) Policy Instruments to make the requisite changes have to be differentiated according to the characteristics of the variable to be affected. F1<Uncertainty Avoidance & Risk> calls for policy measures that reduce, as rapidly as possible, the transaction costs of doing business and adopting innovations[86]. With respect to the variable 'Innovation Costs (Too High)' policies to ensure the increased participation of Arbitrageurs and Government-Backed Venture Capital in the KNSI in terms of intermediation between KBIs and MHTI are a must. F2 <Unsophisticated Markets> calls for, over time, a well-telegraphed ratcheting-up of standards, increasing the number of higher-resolution standards across more sectors, as well as increasing the quality of legislation to enhance competition[87]. F3 <Skills Capacity> involves sector specific pedagogic policy decisions to redesign curricula to match the needs of Industry and improve both quantity and quality of STEMIT personnel across the tertiary and vocational levels. F4 <ICT Incapacity/Incapability> involves economy wide infrastructure policy decisions to add band-width, and reduce costs of ICT.

We find that different Actors assess the factor barriers to innovation differently although there are commonalities.

[81] With respect to the 2014 Global Innovation Index (GII), Kenya's rankings across a range of variables and indicators of innovation and innovativeness are (out of 143): overall rank 85; innovation efficiency ratio 26; regulatory environment 74; business environment 116; human capital and research 117; ICT 106; market sophistication 40; business sophistication 91; knowledge workers 132; innovation linkages 37; university industry research collaboration 37; knowledge and technology outputs 70; Source Global Innovation Index, The Human Factor in Innovation, Cornell University, INSEAD, WIPO, 2014.

[82] It should be noted that those who leave are the risk takers (Docquier, 2006).

[83] Notwithstanding the electoral cycle, or the time taken for legislative and regulatory processes to place policy on statute *via* parliamentary fiscal and monetary decisions (white paper, green paper, committee stage, bill and law). It is fully recognised firstly that such temporal characteristics are subject economically to the consequences (time delay, dislocation, discontinuities) of: (i) exogenous shocks; (ii) market failures; and (iii) Government failures. Secondly, policy business plans and managerial actions are expected to be of a 'rolling' nature in order to attain, through incremental advances, as well as accelerated spurts, higher levels of innovativeness and innovation throughout the economy in the long-term.

[84] Output results are likely to be manifest in the early medium-term as post-graduates emerge into the economy.

[85] By recalibrating and reconfiguring the conditionalities that encapsulate the working environment of knowledge workers and the highly qualified. Kenya ranks 134th (out of 143) for tertiary education in GII 2014 report and 117th for human capital and research and 79th for researchers and must therefore be mindful of retaining national talent.

[86] Kenya ranks 35th (out of 142) for knowledge diffusion but 68th for knowledge creation, 111th for ease of starting a business, 107th for ease of resolving insolvency, 115th for ease of paying taxes (GII 2014 Report). Kenya has slipped from rank 128th (2013) out of 168 for ease of doing business to 134th (2014) out of 189.

[87] According to the Global Competitiveness Report 2014 World Economic Forum, Kenya ranks 96th (out of 148) for 2013/14 compared to 106th for 2012/13, 102nd for 2011/12, 106th for 2010/11 (out of 142), 98th for 2009/10, 93rd for 2008/9 (out of 133), 94th for 2006/7 (out of 125, 93rd for 2005/04.

9.5.5.3 Latent Factors to Barriers to Innovation – Government

***Table 9.8** –Latent Factors to Barriers to Innovation (Government)*

Number of Factor	Government	Variables	Factor Loading	Cronbach's Alpha	Total Varience Explained	KMO	Bartlets Test of Sphericity		
							Chi Square	Df	Significance
1	**Risk & Uncertainty Avoidance**	Excessive Perceived Economic Risk	0.986	0.938	37.988	0.357	475.684	136	0.000
		Restrictive Public/Governmental Regulations	0.892						
		Lack of Explicit Policy Support	0.884						
		Rate of Access to ICT	0.870						
		Lack of Finance	0.963						
		Innovation Costs (Too High)	0.853						
2	**Sophisticated Markets**	Lack of Demanding Customers	-0.809	0.672	15.517				
		Hierarchical Organisations	-0.684						
		Lack of Innovative Customers	-0.620						
3	**Constrained Human Capital Resources**	Lack of Competition	0.961	0.817	14.225				
		Lack of Technically Trained Manpower	0.902						
		Quality of Technically Trained Manpower	0.632						
4	**Information Flow Deficiency**	Lack of Information (Knowledge Gap)	0.895	0.743	8.565				
		ICT Capacity	0.823						
5	**Poor Regulation**	Lack of Higher Resolution Regulations	0.916		6.881				
				Cumulative Total	**83.176**				

NB. Non-Redundant Residuals are computed between observed and reproduced correlations. There are 76 (50.0%) non-redundant residuals with absolute values.

- From the perspective of GOV Respondents Factor 1 <Risk & Uncertainty Avoidance> is the highest barrier to innovation in the KNSI, and in this the variable 'Excessive Perceived Economic Risk' is the most crucial. The factor accounts for 97.2% of the variation in the variable, and is responsible for 38% TVE which is the second highest across actors.
- The variables 'Excessive Perceived Economic Risk' and 'Innovation Costs (Too High)' are consistent with the assessment by ALL Respondents, in that Factor 1 accounts for 97.2% and 72.8% of and 34.8% and 34.7% of the variance in these variables, with respect to GOV and ALL Respondents, and thus the sample and population. GOV Respondents assess these variables as even more critical than ALL Respondents.
- In comparing the similar Factor 1 in GOV and ALL Respondents, we see the factor accounting for nearly 38.0% of the TVE in the first instance and 31.3% of TVE in the second instance. GOV Respondents assess Risk and Uncertainty Avoidance as a more serious barrier.
- Factor 2 <Sophisticated Markets> is the second highest barrier to innovation accounting for 15.517% TVE and influences the policy variables 'Lack of Demanding Customers', 'Hierarchical Organisations' and 'Lack of Innovative Customers' accounting for 65.4%, 46.7% and 38.5% of variance in these variables respectively. Again this factor reflects F2 (ALL Respondents).
- Notably, from GOV Respondents' perspective, Factor 3 <Constrained Human Capital Resources> is the third highest barrier to innovation accounting for 14.2% of TVE. The factor accounts for 92.3%, 81.4% and 39.9% of the variance in the respective variables 'Lack of Competition', 'Lack of Technically Trained Manpower' and 'Quality of Technically Trained Manpower'. This is reflective of F3 <Poor Human Capital> by MHTI Respondents.
- Factor 4 <Information Flow Deficiency> is also a significant barrier to innovation, however it only accounts for 8.6% of the TVE.
- It is notable that the variable 'Lack of explicit policy support' loads on F1 <Risk & Uncertainty Avoidance>. This might suggest that GOV is cognisant that their policy is inadequate. The factor is responsible for 78.1% of the variation in this variable. This perspective of GOV is reflected not by MHTI Respondents but by KBIs in their F4 <Deficient Public Policy>, and ARBS in their F2 <Unsophisticated Markets>, wherein the respective factors account for 55.2% and 32.9% of the variation in the variable.
- Factor 5 <Poor Regulation> is the last significant barrier to innovation, however it only accounts for 6.881% of the TVE, and 8.3% of the total cumulative variance explained (CTVE).
- From a perspective of GOV Respondents, the three most important policy variables are 'Excessive Perceived Economic Risk', 'Restrictive Public/Governmental Regulations' and 'Lack of Explicit Policy Support'.

The key policy implications from GOV identified barriers to innovation Factors 1 to 5 reflect those specific to ALL Respondents and include: (i) F1 <Risk & Uncertainty Avoidance> invokes the policy response of reducing, as rapidly as practicable, economy-wide transactional and transformational costs of doing business and adopting innovation[88]; (ii) F2 <Unsophisticated Markets> implies addressing both the quality and specificity of standards setting and standards to encourage MHTI (BEs) to meet

[88] For example by having transparent and predictable IPRs regime (Isenberg, 2010).

higher resolution standards by adopting (and adapting) new technology and innovating; (iii) F3 <Constrained Human Capital Resources> invokes sector specific pedagogic policy decisions to address the intensity of firm rivalry in terms of enabling rapid entry (business start-ups)[89], and decreasing the ' bargaining power' of incumbents by 'atomising' the business sector through reducing monopoly and oligopoly (Porter, 1990). In addition, to address the quantity and quality of technically trained (STEMIT) manpower by recalibrating curricula reform at tertiary level to the needs of MHTI; (iv) F4 <Information Flow Deficiency> requires the addressing of economy-wide infrastructure policies to expand ICT, band-width and enable accelerated progress towards a full e-economy with GoK conditioning procurement through e-portals and electronic on-line application and filing; (v) F5 <Poor Regulation> invokes overall attention to the recalibration, reconfiguration, quality and enforcement of regulation for fitness of purpose to accelerate innovation and innovativeness in the national economy.

More specifically, the implications are that: (i) In resource constrained circumstances, given the trade-offs, funds and policies should be directed to lowering risks and restrictions in the long-term on the one hand, and on the other hand increasing explicit sector support to STEMIT and MHTI in the short-term. In the long-term, resources should be directed to increasing the culture of innovation and rewarding entrepreneurial risk taking; (ii) Increasing the resolution of standards, predictably over the medium-term, by means of the regulatory system of law making and conditionalities of government procurement to encourage the sophistication of demand and supply markets; (iii) For factor markets to meet higher resolution standards overtime they are forced to be more adaptive of new technology, to become more innovative and hence more productive. However, with reference to availability of policy instruments and success (in overcoming barriers to innovation), ALL Respondents in the range of 52.5%-68.0% indicate that 'Regulation', 'Standards Setting' and 'Government Procurement' are unsuccessful (See Table 9.14 below)[90]. KBI Respondents reflect this at 67.8% with respect to 'Standards Setting' and 76.2% with respect to 'Government Procurement'. Likewise 52.0% to 60.0% of ARBs indicate that 'Standards Setting' is unsuccessful. The view of the GoK regarding policy instrument success is completely at odds with the views of ALL Respondents. This suggests serious misalignments that need to be corrected. (iv) Without adequate human capital resources, especially in STEMIT, economy wide innovation and innovativeness is virtually impossible to achieve. The pivotal role of STEMIT in industrialisation productivity gains and sustainable economic modernisation (from factor driven to innovation driven development) is widely acknowledged as the *sine qua non* of socio-economic advance through structural change[91].

9.5.5.4 Latent Factors to Barriers to Innovation – Medium-High Tech Industry

Table 9.9 –*Latent Factors to Barriers to Innovation (Medium and High-Tech Industry)*

Number of Factor	Industry	Variables	Factor Loading	Cronbach's Alpha	Total Variance Explained	KMO	Bartlets Test of Sphericity		
							Chi Square	Df	Significance
1	**Constrained Opportunities**	Innovation Costs (Too High)	0.806	0.839	34.235	0.744	633.823	136	0.000
		Brain Drain	0.776						
		Rate of Access to ICT	0.669						
		Hierarchical Organisations	0.641						
		ICT Capacity	0.572						
2	**Unsophisticated Markets**	Lack of Demanding Customers	0.938	0.829	12.046				
		Lack of Innovative Customers	0.827						
		Lack of Competition	0.749						
3	**Poor Human Capital**	Lack of Technically Trained Manpower	0.884	0.878	9.592				
		Quality of Technically Trained Manpower	0.747						
4	**Regulator Rigidities**	Lack of Higher Resolution Regulations	0.834	0.608	6.806				
		Organisational Rigidities	0.594						
5	**Restrictive Regulation**	Restrictive Public/Governmental Regulations	0.757		6.569				
				Cumulative Total	**69.248**				

NB: Residuals are computed between observed and reproduced correlations. There are 71 (52.0%) non-redundant residuals with absolute values greater than 0.05.

[89] This also means increasing the availability of substitutes.

[90] In diametric and surprising contrast GOV Respondents in the range 65.4% to 80.0% indicate these three policy instruments are very highly successful.

[91] See: Ju *et al.*, (2011) and the Global Innovation Index 2014: The Human Factor in Innovation, Cornell University, INSEAD, WIPO, 2014, Geneva.

- From the perspective of MHTI Respondents Factor 1 <Constrained Opportunities> is the highest barrier to innovation in the KNSI, in which the 'Innovation Costs (Too High)' is the most crucial variable. Factor 1 accounts for 34.235% of TVE. This is the second highest TVE across Actors. Factor 1 accounts for 64.9% of the variance in the variable, 'Innovation Costs (Too High)' and 60.2% in 'Brain Drain' in the sample and thus the population and universe of MHTI Respondents. This factor reflects F1<Uncertainty Risk & Avoidance > (ALL Respondents) and F1 <Uncertainty Risk & Avoidance > (GOV Respondents).
- Factor 2 <Unsophisticated Markets> the second highest barrier to innovation accounting for 12.046% TVE; influences the policy variables 'Lack of Demanding Customers', 'Lack of Innovative Customers' and 'Lack of Competition'; and, accounts for 88.0%, 68.4% and 56.1% of variance in these variables, respectively. This Factor reflects F2 <Unsophisticated Markets> (ALL Respondents) and F2 <Sophisticated Markets> (GOV Respondents).
- Factor 3 <Poor Human Capital>, the third highest barrier to innovation accounting for 9.592% TVE; influences the policy variables 'Lack of Technically Trained Manpower', 'Quality of Technically Trained Manpower', and accounts for 78.0% and 55.8% of variance in these variables, respectively. This Factor reflects F3 <Skills Capability> (ALL Respondents), F3 <Constrained Human Capital Resources> (GOV Responses).
- Factor 4 <Regulatory Rigidities> is also a significant barrier to innovation in the KNSI; however, it only explains 6.806% of the TVE and influences the policy variables 'Lack of Higher Resolution Regulations', and 'Organisational Rigidities', and accounts for 69.5% and 35.3% of variance in the variables, respectively. However, it must be noted, that the Cronbach's Alpha for this factor is below 0.7, and in keeping to rigorous statistical conventions for the purposes of policy analysis, is deemed questionable in its reliability. This Factor reflects F5 <Poor Regulation> (GOV Respondents).
- Factor 5 <Restrictive Regulation> is also a significant barrier to innovation in the KNSI; however, it only explains 6.569% of the TVE. It accounts for 57.3% of variance in the sole variable 'Restrictive Public/Governmental Regulation'.

Examination of the assessment by GOV and MHTI Respondents of the barriers to innovation shows convergence in the dimensions <<Excessive Risk>>; <<Maladjusted Markets>>; <<Exiguous Human Capital>>; <<Regulatory Deficiencies>>. It is important to note that in Factor 1 for GOV Respondents the variable 'Brain Drain' is not influenced (i.e. does not load on the factor) whereas it loads on the Factor 1 for MHTI Respondents with the second highest loading (0.776 i.e. the Factor is responsible for 60.2% of the variation in the variable). This is telling as the 'Brain Drain' that SSA experiences in general, and Kenya specifically, represents a valuable socio-economic segment of the population that are highly skilled risk takers, innovators, early adopters and early majority (in the diffusion of innovation paradigm). This segment is overwhelmingly professional and technically highly skilled (and in demand in advanced industrialised countries)[92]. Furthermore, the 'Brain Drain' is directly related to the dimension <<Maladjusted Markets>> through the absence of a professionally demanding group of customers (Socio-economic classes A, B)[93].

Given the dimensions identified above, the key policy implication is that within the Kenyan economy, MHTI cannot price risk adequately and hence are severely constrained in opportunities for investing in innovativeness and innovation, especially in the presence of unsophisticated markets that do not demand innovative products and services, as well as regulatory deficiencies that fail to adjust dynamically, over time and space, the standards that govern supply and demand factors.

Other policy implications involve: (i) Government and Industry needing to engage in a standing dialogue to align priorities through targeted policy. This is vital if MHTI is to be able firstly to more accurately price risk as a function of Government transparently signalled legislative intentions regarding higher resolution ICT, 'Lack of Higher Resolution Regulations', and 'Restrictive Public/Governmental Regulations'; (ii) Compliant with WTO obligations, MHTI should be enabled to take advantage of explicit policy support to reduce 'Innovation Cost (Too High)' by Government assisting in financing and defraying the costs of research and development through monetary and fiscal policy[94]; (iii) The 'central nervous system' of the economy – the 'ICT (Network) Capacity' and 'Rate of Access to ICT' – needs to be seriously upgraded in order to enable enhanced information flow, logistics, distribution and transport connectivity, and accelerate the flows of goods, services and DISK. This would generate externalities associated with competition and ICT intermediated business-to-business modalities; (iv) The state and performance of Kenya's ICT system which is provided by the profile of networked readiness provided below in Tables 9.10 and 9.11, as well as Figure 9.22. Specifically, with respect to ICT variables, Kenya ranks 66th and 128st of 148 countries, according to the World Economic Forum (2014).

[92] For example, according to the American Medical Association Physician Masterfile (AMA-PM) 2011, 10,819 physicians were born or trained in 28 SSA countries; 68% were SSA trained, (Tankwanchi*et al*., 2013). According to the Migration Policy Institute (2013) emigration from Kenya Totals 429,000 (Mid 2013 estimates) and Kenya ranks 105th as a sending country. See also: Okoli, N. (2013). Issues and Challenges in Cross-Border in Higher Education: The Sub-Saharan (SSA) Experience. American Journal of Educational Research, 1(1), 11-15; Odhiambo, G. O. (2013). Academic Brain Drain: impact and implications for public higher education quality in Kenya. Research in Comparative and International Education, 8(4), 510-523; and Beine, M., Docquier, F., and Rapoport, H. (2008). Brain drain and human capital formation in developing countries: Winners and losers. The Economic Journal, 118(528), 631-652.

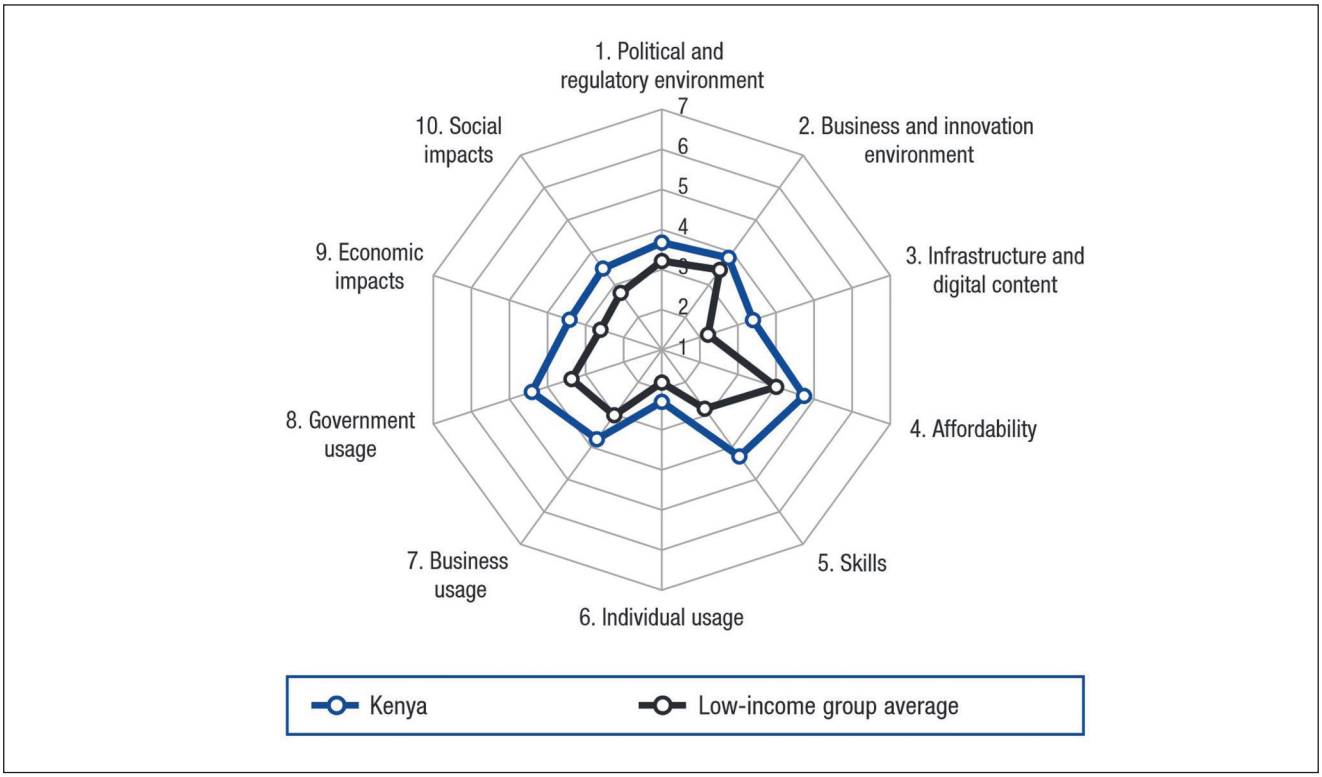
[93] While these socio-economic groups constitute approximately 30% of the population they make up a disproportionately high percentage of those who emigrate.

[94] See: WTO (World Trade Organization), (1994). WTO Non-Actionable Subsidies (R&D, knowledge generation fiscal/monetary support): Agreement on Subsidies and Countervailing Measures. Identification of Non-Actionable Subsidies, s. IV (8).

Table 9.10 –Kenya's Networked Readiness

Kenya's Networked Readiness	Rank (out of 148)	Value (1-7)
Networked Readiness Index 2014	**92**	**3.7**
Networked Readiness Index 2013 (out of 144)	92	3.5
A. Environmental subindex	**92**	**3.8**
1st pillar: Political and regulatory environment	71	3.7
2nd pillar: Business and innovation environment	110	3.8
B. Readiness subindex	**99**	**4.1**
3rd pillar: Infrastructure and digital content	94	3.4
4th pillar: Affordability	97	4.7
5th pillar: Skills	98	4.3
C. Usage subindex	**86**	**3.5**
6th pillar: Individual usage	113	2.3
7th pillar: Business usage	54	3.8
8th pillar: Government usage	46	4.4
D. Impact subindex	**71**	**3.5**
9th pillar: Economic subindex	55	3.4
10th pillar: Social impacts	83	3.5

Figure 9.22 –Kenya Compared to Lover Middle Income Group Average



Source: Dutta, S, Bilbao-Osorio, B and Lanvin, B., eds. 2014. The Global Information Technology Report 2014: Rewards and Risks of Big Data. 10: 92-95044-63-0. Geneva: World Economic Forum.

Table 9.11–Kenya's Networked Readiness (Details)

The Networked Readiness Index in Details					
Indicator	**Rank/148**	**Value**	**Indicator**	**Rank/148**	**Value**
1st Pillar: Political and Regulatory Environment			**6th Pillar: Individual Usage**		
Effectiveness of law-making bodies*	50	4.0	Mobile phone subscriptions, 100/pop.	121	71.2
Laws relating to ICT*	62	4.1	Individuals using Internet, %	95	32.1
Judicial independence*	60	4.0	Households with personal computer, %	113	10.8
Efficiency of legal system in settling disputes*	57	3.9	Households with Internet access, %	103	11.5
Efficiency of legal system in changing regulations*	56	3.7	Broadband Internet subscription, 100/pop	128	0.1
Intellectual property protection*	86	3.4	Mobile broadband subscription, 100/pop	116	2.2
Software piracy rate, % software installed	81	78	Use of virtual social networks*	81	5.5
No. of procedures to enforce a contract	126	33	**7th Pillar: Business Usage**		
No. of days to enforce a contract	51	465	Firm-level technology absorbtion	66	4.8
2nd Pillar: Business and Innovation Management			Capacity for innovation	34	4.1
Availability of latest technologies*	71	5.0	PCT patents, applications, million/pop	93	0.2
Venture capital availability*	47	3.0	Consumer-to-business Internet use*	57	5.0
			Business-to-consumer Internet use*	66	4.6
Total tax rate, % profits	102	44.2	Extent of staff training*	54	4.2
No. of days to start a business	114	32	**8th Pillar: Government Usage**		
No. of procedures to start a business	119	10	Importance of ICTs to gov't vision*	26	4.7
Intensity of local competition*	35	5.4	Gov't Online Service Index 0-1 (best)	86	0.43
Tertiery education gross enrollment rate, %	141	4.0	Gov't success in ICT promotion	31	4.9
Quality of management schools*	57	4.4	**9th Pillar: Internet Impacts**		
Government procurement of advanced tech.*	79	3.4	Impact of ICT on news services and products*	41	4.8
3rd Pillar: Infrastructure and Digital Content			ICT PCT patents, applications/million pop	81	0.0
Electricity production, kWh/capita	125	186.8	Impact of ICT on new organizational models*	52	4.5
Mobile network coverage, %/population	117	89.1	Knowledge-intensive jobs, % workforce	n/a	n/a
Int'l Internet bandwidth, kb/s per user	66	23.7	**10th pillar: Social impacts**		
Secure Internet servers, million/population	103	4.2	Impacts of ICT on access to basic services*	62	4.3
Accessibility of digital content*	79	4.9	Internet access in schools*	81	4.0
4th Pillar: Affordability			ICT use & government efficiency*	57	4.4
Mobile celular tariffs, PPP $/minute	21	0.09	E-participation index, 0-1 (best)	107	0.05
Fixed broadband Internet tariffs, PPP $/month	119	65.18			
Internet & telephony competition, 0-2 (best)	1	2.00			
5th Pillar: Skills					
Quality of educational system*	44	4.2			
Quality of math and science education*	95	3.8			
Secondary education gross enrollment rate, %	112	60.1			
Adult literacy rate, %	97	87.4			

Note: Indicators followed by an asterisk* are measured on a 1-to-7 (best) scale. For further details and explanation, please refer to the section "How to read the Country/Economy Profiles" on page 97 of the Global Information Technology Report 2012.

9.5.5.5 Latent Factors to Barriers to Innovation – Knowledge-Based Institutions

Table 9.12 – *Latent Factors to Barriers to Innovation (Knowledge-Based Institutions)*

Number of Factor	KBI	Variables	Factor Loading	Cronbach's Alpha	Total Variance Explained	KMO	Bartlets Test of Sphericity		
							Chi Square	Df	Significance
1	ICT Capacity/Capability	Rate of Access to ICT	0.875	0.788	35.669	0.84	1188.936	136	0.000
		ICT Capacity	0.803						
		Restrictive Public/Government Regulations	0.652						
2	Poor Human Capital	Lack of Technically Trained Manpower	0.808	0.822	10.057				
		Quality of Technically Trained Manpower	0.785						
3	Unsophisticated Markets	Lack of Demanding Customers	0.830	0.808	7.514				
		Lack of Innovative Customers	0.809						
		Lack of Competition	0.777						
4	Deficient Public Policy	Lack of Explicit Policy Support	0.743		6.374				
5	Risk Aversity	Innovation Costs (Too High)	0.833	0.605	5.998				
		Excessive Perceived Economic Risk	0.586						
		Lack of Finance	0.572	**Cumulative Total**	**65.613**				

NB: Residuals are computed between observed and reproduced correlations. There are 70 (51.0%) non-redundant residuals with absolute values greater than 0.05.

- From the perspective of KBI Respondents, Factor 1 <ICT Capacity/Capability> is the highest barrier to innovation in the KNSI, in which the 'Rate of Access to ICT' and 'ICT Capacity' and are the most crucial variables. The Factor accounts for 76.6% and 64.5% of the variance in the respective variables. Factor 1 accounts for 35.669% of TVE. This makes it the third highest TVE across Actors. It reflects; F4 <ICT Incapacity/Incapability> (ALL Actors), F1 <Constrained Opportunities> (MHTI Respondents).
- Factor 2 <Poor Human Capital>, the second highest barrier to innovation accounting for 10.057% TVE, influences the policy variables 'Lack of Technically Trained Manpower, and 'Quality of Technically Trained Manpower', and accounts for 65.3%, and 61.6% of variance in the variables, respectively. Again this factor reflects F3 (GOV and MHTI Respondents). This Factor reflects F3 <Skills Capacity> (ALL Respondents), F3 <Constrained Human Capital Resources> (GOV Respondents), F3 <Poor Human Capital> (MHTI Respondents).
- Notably, Factor 3 <Unsophisticated Markets> is the third highest barrier to innovation. The factor accounts for 7.514% TVE and accounts for 68.9%, 65.4% and 60.4%, of the variance in the respective variables ('Lack of Demanding Customers, 'Lack of Innovative Customers', and 'Lack of Competition'). This factor reflects F2 <Unsophisticated Markets> (ALL Respondents), F2 <Sophisticated Markets> (GOV Respondents), F2 <Unsophisticated Markets> (MHTI Respondents).
- Factor 4 <Deficient Public Policy> is also a significant barrier to innovation; however it only explains 6.374% of the TVE. The factor accounts for 55.2% of the variance in the sole variable 'Lack of Explicit Policy Support.
- Factor 5 <Risk Aversity> is also a significant barrier to innovation; however it only explains 5.998% of the TVE. The factor accounts for 69.4%, 34.3% and 32.7% of the variance in the respective variables 'Innovation Costs (Too High)' and 'Excessive Perceived Economic Risk' and 'Lack of Finance'. The Cronbach's Alpha for this factor is below 0.7 therefore is deemed unreliable for policy purposes. This Factor reflects F1 <Uncertainty Avoidance & Risk> (ALL Respondents) (GOV Respondents) and F1 <Constrained Opportunities> (MHTI Respondents).

The key policy implication is that for KBIs without a functional and high-performance 'central nervous system' of the economy in the form of high ICT capacity and capability, as well as adequate threshold levels of human capital, the level of innovativeness and rate of innovation in the economy is likely to be debilitating and inadequate to close the gap with the median middle-income countries[95].

Secondary implications are: (i) KBI view of Factor 3 <Unsophisticated Markets> is convergent with the view of ALL Respondents (Factor 2), GOV Respondents (Factor 2), MHTI Respondents (Factor 2), should be viewed through the lens of KBI inter-linkages with other Actors, which are either missing for HE, with respect to RIs, ARB, FI, ISTC and BEs, or very weak and non-existent for RI (see Figures 9.7 and 9.8 above). The isolation of KBIs may (counter-intuitively) reinforce their appreciation and understanding of connectedness and markets as a key determinant of innovation and NSI (Bartels *et al*., 2012); (ii) Even if KBIs wish to commercialise DISK, due to their very weak or non-existent linkages, they find no reception in the market because of the 'ICT Capacity/ Capability' barrier. One of the primary sources of DISK is RI, and RI inter-linkages with FIs, GOV, ISTC and BEs are non-existent. This is confirmed with respect to an Actor-centric view of the KNSI, in which KBI have no proactive linkages with ARB, and ARB have no proactive linkages with KBIs. 59.2% of

[95] See Kenya recalculates its GDP Figures, the Economist (2014) which will make its economy a lower-middle income Economy, 15th April.

KBIs view the proactive link [ARB] ARB-HE as VI-VW. MHTI has no proactive or passive linkages with KBI and vice versa, (See Figures 9.12 and 9.13 above); (iii) KBIs are far distant from fully reorienting what should be their entrepreneurial role toward corporate entrepreneurship in which, incentivised by governmental fiscal, monetary, regulation standards and performance requirements, they become more business minded to exploit and commercialise DISK; and, (iv) Despite the Government's relationship with KBI, with respect to innovativeness and innovation performance requirements (See Figures 9.12 and 9.13 above), barriers tend to preclude sufficient adaptive behaviour by KBIs.

9.5.5.6 Latent Factors to Barriers to Innovation – Arbitrageurs

***Table 9.13** – Latent Factors to Barriers to Innovation (Arbitrageurs)*

Number of Factor	ARB	Variables	Factor Loading	Cronbach's Alpha	Total Variance Explained	KMO	Bartlets Test of Sphericity		
							Chi Square	Df	Significance
1	**Poor Human & Risk Capital**	Brain Drain	0.858	0.862	38.461	0.369	282.095	136	0.000
		Innovation Costs (Too High)	0.827						
		Quality of Technically Trained Manpower	0.756						
		Lack of Technically Trained Manpower	0.744						
2	**Unsophisticated Markets**	Lack of Demanding Customers	0.804	0.471	11.725				
		Lack of Innovative Customers	0.596						
		Lack of Explicit Policy Support	-0.574						
3	**Organisational Rigidities**	Hierarchical Organisations	0.851	0.701	10.039				
		Organisational Rigidities	0.763						
4	**ICT & Financial Incapacity**	ICT Capacity	0.865	0.281	8.525				
		Lack of Finance	0.789						
5	**Restrictive Regulatory Risk**	Restrictive Public/Governmental Regulations	0.799	0.746	6.644				
		Excessive Perceived Economic Risk	0.751	**Cumulative Total**	**75.394**				

NB: Residuals are computed between observed and reproduced correlations. There are 69 (50.0%) non-redundant residuals with absolute values greater than 0.05

- From the perspective of ARB Respondents, Factor 1 <Poor Human & Risk Capital> is the highest barrier to innovation in the KNSI, in which the 'Brain Drain' and 'Innovation Costs (Too High)' are the most crucial variables. The Factor accounts for 73.6% and 68.4% of the variance in the respective variables. Factor 1 accounts for 38.461% of TVE, which is the highest of all and reflects Factor 3 (GOV and MHTI), Factor 2 (KBIs)
- Factor 2 <Unsophisticated Markets>, the second highest barrier to innovation accounting for 11.725% TVE, influences the policy variables 'Lack of Demanding Customers', 'Lack of Innovative Customers' and 'Lack of Explicit Policy Support', and accounts for 64.6%, 35.5% and 32.9%, of variance in the variables, respectively. The Cronbach's Alpha is well below the limit of acceptable reliability. This reflects F2 (ALL Respondents), F2 (GOV, MHTI) Factor 3 (KBI).
- Factor 3 <Organisational Rigidities>, the third highest barrier to innovation accounting for 10.039% TVE, influences the policy variables 'Hierarchical Organisations' and 'Organisational Rigidities' which account for 72.4% and 58.2% of variance in the variables, respectively.
- Factor 4 <ICT & Financial Incapacity>, the fourth highest barrier to innovation accounting for 8.525% TVE, influences the policy variables 'ICT Capacity', and 'Lack Of Finance', which account for 74.8% and 62.3% of variance in the variables, respectively. The Cronbach's Alpha is well below the limit of acceptable reliability.
- Factor 5 <Restrictive Regulatory Risk>, the fifth highest barrier to innovation accounting for 6.664% TVE, influences the policy variables 'Restrictive Public Governmental Regulations', and 'Excessive Perceived Economic Risk' which account for 63.8% and 56.4% of variance in the variables, respectively. This reflects Factor 1 (GOV), Factor 5 (MHTI), Factor 5 (KBIs).

The key policy implication from the combination of the dearth of talent and risk capital and unsophisticated markets on the one hand; and on the other hand, organisational rigidities and the restrictive and risky business environment are: (i) There are insufficient options for taking equity positions in incubation, spin-offs and start-ups in terms of either ideation and invention or raising investment funds. This is especially serious for FIs and VC[96]; (ii) The inability to price adequately risk; (iii) The business environment is not supportive of, and continues to constrain, intermediation especially given the absent linkages between BEs-ARBs-RIs/HE; and (iv) The rate of ideation, invention, commercialisation is probably well below the level that the VC industry in Kenya would wish for.

Secondary implications, especially for Knowledge-brokers, concern: (i) The loss of inventiveness through the Brain Drain presents the greatest of barriers to their intermediation role; (ii) Without a critical mass of risk-welcoming talent (usually the well-educated) opportunities for intermediation are severely restricted; and (iii) Resource allocation decisions are likely to be less than effective and efficient than otherwise.

[96] This is despite the indications that private equity activities in Kenya, according to Deloitte 2013 East Africa Private Equity Confidence Survey, is buoyant and third only to S. Africa and Nigeria; and Kenya leads in East Africa Private Equity sentiment.

An overview of the factor barriers to innovation assessed by ALL Respondents as well as the different Actors in the KNSI discloses four major recurrent policy dimensions that constrict innovativeness and innovation and explain, in tandem with absent and/or the general very weak Actor inter-linkages, the overall very low levels of innovativeness of BEs identified earlier.

These policy dimensions, ultimately the targets of applied resources, are as follows: <Excessive Risk>>; <Maladjusted Markets>>; <<Exiguous Human Capital>>; and <<Regulatory Deficiencies>>. The first dimension <<Excessive Risk>> is manifest as a combination of a number of high economic risks, and transformational and transactional costs. The second, <<Maladjusted Markets>>, is manifest as completely insufficient level and low quality of demand. The third dimension, <<Exiguous Human Capital>> is manifest in the rate, quantity and quality of skills formation commensurate with an innovation driven economy (Hall & Mairesse, 2006; Goh, 2005). Fourthly, <<Regulatory Deficiencies>> are manifest as a composite of low resolution standards and high rigidity in regulation and institutional 'rules of the game'.

Interestingly, while it is obvious that resources are limited in Kenya and the KNSI, the variable 'Lack of Finance' does not load on any factor barrier to innovation (ALL Respondents)[97] and loads only on Factor 1 (GOV), Factor 5 (KBIs), Factor 4 (ARBs). MHTI Respondents do not assess 'Lack of Finance' as a variable barrier to innovation.

Taken together, these four policy dimensions are responsible for the present state of the KNSI, which can be characterised as: (i) Asymmetric in the density, directionality and distribution of Actor inter-linkages and hence lacking in strategic coherence and convergence, organisational high-level performance and exploitable externalities; (ii) Relatively slow in being responsive to supply- and demand-side signals[98]; (iii) Systematically rigid and inflexible to changing conditions; and, (iv) Isolation of KBIs which constitute the key source of formalised technical knowledge.

The policy recommendations to address the dimensions and factor barriers to innovation and innovativeness should be viewed together through the lens of a short-, medium- and long-term frame of reference. A matrix of such is presented further on in the Report to guide policy-making.

The policy recommendations to address <<Excessive Risk>> within the KNSI include policies to counter the obstacles to innovativeness and entrepreneurship i.e. (i) Reconfiguring the procedural system in terms of eliminating bottlenecks in permits for doing business; (ii) Revamping the Government Backed Venture Capital and development finance to facilitate access to credit for innovative entrepreneurship and R&D demonstration and pre-commercialisation stages; (iii) Recalibrating the fiscal regime to favour innovative entrepreneurship[99]; (iv) Initiating programmatic co-ordination of support to innovation in MHTI and KBIs conditional on triangulation (MHTI-KBIs-ARBs); and, (v) Initiating a triangulation programme to enhance the absorptive capacity and adaptive capability, regarding imported and local technologies, in micro-small-and medium-sized enterprises (MSMEs) in MHTI.

The policy recommendations to address <<Maladjusted Markets>> with respect to the KNSI include: (i) Using the regulatory framework for adjusting (spatially and temporarily) the standards and performance requirements that regulate markets such that MHTI firms are coerced towards higher levels and rates of technological adaptation *via* environmental standards, economic performance measures as well as directives on innovation in specific strategic sectors; (ii) Use of standards setting for increasing the rates of substitutions of capital for labour in order to dynamise markets[100];(iii) Reconfiguring government and public monopolistic procurement terms and conditions to encourage innovation (e-filling, triangulation, R&D component of contract bidding, etc.,); (iv) With the perspective of technology/product 'push', strengthen the incentives framework for the commercialisation of R&D in KBIs; and, (v) Initiation of a trade-mark and patent management corporation to coordinate the commercialisation of IPRs from publicly funded R&D.

The policy recommendations to address <<Exiguous Human Capital>> include: (i) Recalibrating curricula, especially at the tertiary level (with feed through to the secondary level), to the needs of MHTI; (ii) Reconfiguring the quality and quantity of secondary and tertiary, as well as vocational and enterprise-based training towards STEMIT and management to permit skills upgrading commensurate with capital substitution for labour; (iii) Increasing the autonomy (fiscal and management) of KBIs conditioned on performance requirements that favour conjoint training programmes with MHTI (such as STEMIT programmes embedded in business enterprises) and triangulation; (iv) Given the spatiality of the KNSI, upgrading continuously the ICT infrastructure to enable (A) Link-up of the locations contributing most to GDP on a priority basis, (B) Lower ICT costs, and (C) Link-up of all KBIs, RIs and Government STEMIT related agencies in creating a high-band-width, high speed national DISK, education and research network; and, (v) Mitigating the 'Brain Drain' by instigating a series of GoK sponsored national human capital conferences to encapsulate Kenyans overseas in national development[101].

[97] This is not the case with the Ghana NSI barriers to innovation.

[98] This is a reciprocal challenge. On the one hand the demand-side is unsophisticated in its needs and wants in products and services; and on the other hand (due to poor quality of demand) the supply-side offers little or no innovation or innovative products and services at a level and rate to catalyse innovativeness. Also, from a diffusion of innovation perspective, the size of the market for innovative products and services is relatively small in Kenya.

[99] In terms for example of altering depreciation rates to permit more rapid replacement of capital assets.

[100] It is to be noted that higher level of capital investments requite require high levels of skilled labour (Griliches, 1969; Katz & Margo, 2013).

[101] As the global competition for the highly skilled shows no sign of abating, policies have to be tailored to include nationals abroad (OECD, 2008).

The policy recommendations to address <<Regulatory Deficiencies>> include: (i) Reconfiguring the legislative framework for business entrepreneurship in order to reduce rapidly the process, time, and costs associated with commercialisation and start-ups; (ii) Enabling the collateral of property assets to be used more intensely; (iii) Encouraging investment in MSMEs in MHTI through fiscal reform; (iv) ensuring the protection of investors through the courts and accelerating the processes of insolvency to enable more rapid exit (and hence entry) in business sectors; (iv) Reducing barriers to trans-border trade and investment; and, (vii) Aligning incentives regulation to encourage innovation.

Survey Analysis: Excessive Risk, Maladjusted markets, coupled with exiguous human capital and regulatory deficiencies.

Policy Implication: Barriers to innovation to be tackled economy-wide as well as in terms of Actor-specific interventions.

Policy Recommendation: Use Government Backed Venture capital to support innovation, use standards to increase the rate of capital substitution for labour, emphasise recalibration of education towards STEMIT in triangulation with MHTI and ARBs and eliminate bottlenecks in doing business.

9.5.6 Success of Policy Instruments and Barriers to Innovation

The identification of the policy dimensions, factors and variables acting as high barriers to innovativeness and innovation in the KNSI suggests policy implications. The disposition of the factors suggests the sequencing of policy prescriptions and recommendations. However, such policy prescriptions and recommendations, in terms of Actor business plans and management actions need to be set in the context of the extant policies of Government with respect to supporting innovativeness and innovation in the economy, and their success. To this end, an analysis of success of policy instruments and barriers to innovation was performed and is presented in Table 9.14.

Table 9.14 below indicates the cross-tabulation significant relationships between success of policy instruments and barriers to innovation as discussed in the section below. From all the statistically significant (≥95% confidence level) cross-tabulation results, only those results representing a majority assessment (≥50%) by Respondents are reported. As an overview we can see that there is a varied response to whether the available policy instruments are successful or unsuccessful with respect to barriers to innovation, and whether or not the barrier to innovation is a very high or low constraint. The specifics of these cross-tabulations are indicated below.

A cursory examination of Table 9.14 shows that firstly, ALL Respondents do not have a significant evaluation of the policy instrument ICT Access. Secondly, GOV Respondents have a significant assessment of VHS-VLC on ALL policy instruments with respect to barriers to innovation. This is in stark contrast to MHTI Respondents who have no significant assessment of any of the success of policy instruments in overcoming and barriers to innovation. Thirdly, KBIs have a US-VHC view on only three policy instruments [Government-Backed Venture Capital, Standard Setting, and Labour Mobility Laws (laws, Incentives)]. Fourthly, ARBs have an assessment on US-VHC only on three policy instruments [Subsidised Loans, Standard Setting, and Labour Mobility Laws (laws, Incentives)].

A second set of significant observations from ALL Respondents indicate that the following variables of barriers to innovation which load highly on latent factors (Table 9.7 above) do not appear as a very high constraint in the context of policy instrument success: 'Brain Drain'; 'Hierarchical Organisations'; 'Lack of Higher Resolution Regulations'; and 'ICT Capacity'. Furthermore, while GOV Respondents in the overwhelming majority indicate positively that policy instruments are successful in overcoming the variable barriers to innovation i.e. VHS-VLC, a retrospect of Table 9.8 Latent Factors to Barriers to Innovation Government indicates the same variables as high barriers to innovation. Particularly; 'Lack of Demanding Customers', 'Lack of Innovative Customers', 'Lack of Competition', and 'Lack of Technically Trained Manpower', are assessed by GOV Respondents as significantly high barriers to innovation. This is the <<Maladjusted Markets>> dimension. It is instructive that GOV Respondents emphasise <<Maladjusted Markets>> as constituting obstacles to the KNSI yet assess very positively that policy instruments are VHS-VLC with respect to markets which are unsophisticated. This is indicative of contradictions in GOV Respondents, with respect to other KNSI Actors in the light of GOV isolation (See Fig 9.3 Above) from other Actors except HE, concerning GoK perspective on the performance, effectiveness and efficiency of the KNSI.

KBI and ARB Respondents, in contrast to GOV Respondents, are consistent in that they assess the 'Lack of Finance', 'Lack of Explicit Policy Support', as constituting high barriers to innovation; and evaluate as US-VHC the policy instruments – 'Government Procurement', 'Standard Setting', 'Labour Mobility (Laws, Incentives)', and 'Subsidised Loans', with respect to these particular barriers to innovation variables.

Firstly, some assessments of policy instruments success and barriers to innovation (US-VHC) by ALL Respondents are corroborated (by the other Actors in the KNSI). These are discussed below.

- Subsidised Loans – are inadequately configured and calibrated to remove barriers to innovation: 'Lack of Finance' (ARBs).
- Government Procurement – is inadequately configured and calibrated to remove barriers to innovation: 'Lack of Finance' (KBIs).

Table 9.14 – *Policy Instrument Success and Barriers to Innovation*

Policy Instrument Success and Barriers to Innovation											
		All Actors %		Government %		MHTI %		KBIs %		Arbitrageur %	
Policy Instrument	Barriers to Innovation	VHS-VLC	US-VHC	VHS-VLC	US-VHC	VHS-VLC	US-VHC	VHS-VLC	US-VHC	VHS-VLC	US-VHC
Research Grants	Lack of Competition			79.2	8.4						
	Lack of Demanding Customers			79.1	4.2						
	Lack of Innovative Customers			83.3	8.4						
	Rate of Access to ICT	63.4	31.2								
Subsidised Loans	Lack of Finance	1.5	60.8							4.0	64.0
	Lack of Demanding Customers			73.1	7.6						
	Lack of Innovative Customers			73.1	7.6						
Government Backed Venture Capital	Lack of Explicit Policy Support	4.9	56.3								
	Lack of Competition	20.5	51.4	73.0	11.4						
	Lack of Demanding Customers			76.9	3.8						
	Lack of Innovative Customers			76.9	7.6						
Government Procurement	Lack of Finance	1.5	68.0					1.2	76.2		
	Quality of Technically Trained Manpower	7.4	52.7								
	Lack of Competition			65.4	3.8						
	Lack of Demanding Customers			73.0	3.8						
	Lack of Innovative Customers			73.0	3.8						
	Organisational Rigidities	4.4	55.5								
	Excessive Perceived Economic Risk	6.4	51.9								
Standard Setting	Lack of Explicit Policy Support	6.6	54.8							12.0	60.0
	Lack of Finance	3.0	61.3					1.8	67.8		
	Lack of Competition			69.2	3.8						
	Lack of Innovative Customers			76.9	3.8						
	Lack of Information (Knowledge Gap)									12.0	52.0
Regulation	Lack of Explicit Policy Support	8.5	52.5								
	Lack of Competition			73.0	7.6						
	Lack of Innovative Customers			80.0	7.6						
Labour Mobility Laws (laws, incentives)	Lack of Explicit Policy Support	3.7	57.1							12.0	56.0
	Lack of Finance	3.3	66.8					2.4	77.0		
	Lack of Technically Trained Manpower			61.5	15.3						
	Quality of Technically Trained Manpower	9.8	51.9								
	Lack of Competition	14.7	25.3	69.1	11.5						
	Lack of Demanding Customers			73.0	7.6						
	Lack of Innovative Customers			73.0	7.6						
	Innovation Costs (Too High)	4.1	57.8								
	Excessive Perceived Economic Risk	7.4	50.0								
ICT Access	Lack of Technically Trained Manpower			65.3	0.0						
	Lack of Competition			76.8	0.0						
	Lack of Demanding Customers			84.5	0.0						
	Lack of Innovation Customers			84.5	0.0						

VHS-VLC = Very High Successful (Policy Instrument) – Very Low Constraint (Barrier to Innovation)
US-VHC = Unsuccessful (Policy Instrument) – Very High Constraint (Barrier to Innovation)

- Standard Setting – is inadequately configured and calibrated to remove barriers to innovation: 'Lack of Explicit Policy Support' (ARBs); 'Lack of Finance' (KBIs).
- Labour Mobility Laws (Laws, Incentives) – are inadequately configured and calibrated to remove barriers to innovation: 'Lack of Explicit Policy Support' (ARBs); 'Lack of Finance' (KBIs).

Secondly, some assessments of policy instruments success and barriers to innovation (US-VHC) by ALL Respondents are not corroborated by the other Actors in the KNSI. Multiple policy instruments map to a singular barrier to innovation variable (not including the corroborations), which are discussed below:

- Regarding the barrier to innovation 'Lack of Explicit Policy Support', two policy instruments – Government-Backed Venture Capital and Regulation – are inadequately configured and calibrated to remove the barrier.
- Regarding the barrier to innovation 'Quality of Technically Trained Manpower', two policy instruments – Government Procurement and Labour Mobility Laws (Laws, Incentives) – are inadequately configured and calibrated to remove the barrier.
- Regarding the barrier to innovation 'Excessive Perceived Economic Risk', two policy instruments – Government Procurement and Labour Mobility Laws (Laws, Incentives) – are inadequately configured and calibrated to remove the barrier.

Thirdly, some assessments of policy instruments' success and barriers to innovation (US-VHC) by ALL Respondents are not corroborated by the other Actors. Singular policy instruments map to a singular barrier to innovation variable, which are discussed below:

- Government Procurement – is inadequately configured and calibrated to remove barrier to innovation: 'Organisational Rigidities'.
- Labour Mobility Laws (Laws, Incentives) is inadequately configured and calibrated to remove barrier to innovation: 'Innovation Costs (Too High)'.

Fourthly, some assessments of policy instruments success and barriers to innovation (US-VHC) by Actor Respondents are not corroborated by the other Actors. Singular policy instruments map to singular barriers to innovation variable, which are discussed below from an Actor perspective:

- To reiterate, from the GOV perspective, no policy instrument is assessed as unsuccessful (US-VHC) with respect to barriers to innovation in contradiction to KBIs and ARB Respondents.
- From the MHTI perspective there is no significant policy instrument success with respect to overcoming barriers to innovation.
- From the KBI perspective:
  - o Government Procurement – is inadequately configured and calibrated to remove the barrier to innovation: 'Lack of Finance'
  - o Standard Setting – is inadequately configured and calibrated to remove the barriers to innovation: 'Lack of Finance'
  - o Labour Mobility Laws (Laws, Incentives) – are inadequately configured and calibrated to remove the following barrier to innovation: 'Lack of Finance'
- From the ARB perspective:
  - o Subsidised Loans – are inadequately configured and calibrated to remove the barrier to innovation: 'Lack of Finance'
  - o Standard Setting – is inadequately configured and calibrated to remove the barriers to innovation: 'Lack of Explicit Policy Support' and 'Lack of Information (Knowledge-Gap)'
  - o Labour Mobility Laws (Laws, Incentives) – are inadequately configured and calibrated to remove the following barrier to innovation: 'Lack of Explicit Policy Support'

Bearing in mind the policy dimensions of the factor barriers identified previously, the policy analysis above shows patterns with respect to policy instruments success (or lack of) and barriers to innovation. These reflect the factor barriers to innovation. In general, policy instruments are neither well-configured nor adequately calibrated to address barriers to innovation in the KNSI according to ALL, KBIs and ARB Respondents, but not GOV Respondents. From the perspective of ALL Respondents, first US-VHC is densest across policy instruments and barriers to innovation: 'Lack of Finance' and 'Lack of Explicit Policy Support' [not overcome by Subsidised Loans. Government Procurement, Standard Setting, Labour Mobility Laws (Laws, Incentives), Government-Backed Venture Capital and Regulation]. The second densest is across: 'Lack of Competition', 'Quality of Technically Trained manpower', 'Excessive Perceived Economic Risk' [not overcome by Government-backed Venture Capital, Government Procurement, Labour Mobility Laws (Laws, Incentives)]. The third densest is across: 'Organisational Rigidities', 'Innovation Costs (Too High)' [not overcome by Government Procurement, Labour Mobility Laws (Laws, Incentives)].

Firstly, from an Actor perspective, the rank (descending) order of significant assessment of policy instruments and barriers is: GOV (twenty-three assessments)[102]; ARB (four); and, KBI (three). Secondly, regarding US-VHC, from the Actor's perspective, the most recurrent barriers inadequately addressed by policy instruments are: (i) 'Lack of Finance' (three, KBI) is inadequately addressed by policy instruments – Subsidised Loans, Government Procurement, Standards Setting, and, Labour Mobility (Laws, Incentives); (ii) 'Lack of Explicit Policy Support' (two, ARB) is inadequately addressed by policy instruments – Standard Setting, Labour Mobility (Laws, Incentives); (iii) 'Lack of Finance' (one, ARB) and 'Lack of Information (Knowledge Gap)' (One, ARB) are inadequately addressed by policy instruments – Subsidised Loans and Standard Setting, respectively.

[102] All in the majority positively assessed ac VHS-VLC. The GOV Respondents are divergent from other KNSI Actors in their evaluation of policy instrument success in overcoming the barriers to innovation they deem significantly high.

It is notable that ALL Respondents do not associate significantly success (or failure) of policy instruments regarding the variable barriers to innovation: 'Brain Drain', 'Hierarchical Organisations', 'Lack of Higher Resolution Regulations', and 'ICT Capacity'. It is instructive, however, to examine at a finer grain, the variable barrier to innovation that is the most influenced by the factors across ALL and each set of Actor Respondents[103]. This is 'Brain Drain' – for which (ALL) Factor 1 <Uncertainty Avoidance and Risk> is responsible for 63.4% of the variation in the variable. Likewise, 'Excessive Perceived Economic Risk' – for which (GOV) Factor 1 <Risk and Uncertainty Avoidance> is responsible for 97.2% of the variation in the variable; 'Innovation Costs (Too High)' – for which (MHTI) Factor 1 <Constrained Opportunities> accounts for 65.0% of the variation in the variable; 'Rate of Access to ICT' – for which (KBI) Factor 1 <ICT Capacity/Capability> accounts for 76.6% of the variation in the variable, and 'Brain Drain' – for which (ARBs) in Factor 1 <Poor Human and Risk Capital>, the factor accounts for 73.6% of the variation of this variable (see Tables 9.7, 9.8, 9.9, 9.12 and 9.13 above).

It is also instructive to examine each of the variables of latent barriers to innovation which load the highest across ALL and each of the Actor Respondents (irrespective of the TVE explained by the underlying Factor). This is 'Lack of Technically Trained Manpower' for ALL Respondents in which the Factor 3 <Skills Capacity/Capability> is responsible for 66.3% of the variable's variation in the sample and hence the population. It is 'Excessive Perceived Economic Risk' for GOV Respondents in which the Factor 1 <Risk and Uncertainty Avoidance> accounts for 97.2% of the variables variance. For MHTI Respondents it is 'Lack of Demanding Customers' in Factor 2 <Unsophisticated Markets>, which accounts for 88.0% of the variable's variation. For KBI Respondent it is the 'Rate of Access to ICT' in Factor 1 <ICT Capacity/Capability> which accounts for 77.6% of the variation in the variable. Finally, it is 'Brain Drain' for ARB Respondents in Factor 1 < Poor Human and Risk Capital> wherein the factor accounts for 73.6% of the variables variation[104].

On ranking the factors (by KNSI Actor) by the TVE in descending order (a measure of the explanatory power of the Factor, which enables prioritisations, decision trade-offs, targeting and sequencing in policy craft), we see the pattern in Table 9.15 – Ranking of Factor (Total Variance Explained).

Table 9.15 – *Ranking of Factor (Total Variance Explained)*

Rank	Actor	Factor	% TVE
1st	ARB	‹Poor Human & Risk Capital›	38.461
2nd	GOV	‹Risk & Uncertainty & Avoidance›	37.988
3rd	KBI	‹ICT Incapacity Incapability›	35.669
4th	MHTI	‹Constrained Opportunities›	34.235
5th	GOV	‹Sophisticated Markets›	15.057
6th	GOV	‹Constrained Human Capital Resources›	14.255
7th	MHTI	‹Unsophisticated Markets›	12.046
8th	ARB	‹Sophisticated Markets›	11.725
9th	KBI	‹Poor Human Capital›	10.057
10th	ARB	‹Organisational Rigidities›	10.039
11th	MHTI	‹Poor Human Capital›	9.592
12th	GOV	‹Information Flow Defficiency›	8.565
13th	ARB	‹ICT & Financial Incapabilities›	8.525
14th	KBI	‹Unsophisticated Markets›	7.514
15th	GOV	‹Poor Regulations›	6.881
16th	MHTI	‹Regulatory Rigidities›	6.806
17th	ARB	‹Restrictive Regulatory Risk›	6.664
18th	MHTI	‹Restrictive Regulation›	6.569
19th	KBI	‹Defficient Public Policy›	6.374
20th	KBI	‹Risk Aversity›	5.998

[103] In the Factor responsible for most of the TVE (i.e. the most crucial Factor which is Factor 1).

[104] The highest loading variable 'ICT Capacity' (on Factor 4 <ICT and Financial Incapacity> is associated with an unacceptable Cronbach's Alpha hence the choice of the second highest loading variable for policy analysis.

NOTE: Table 9.15 should be read with the TVE rank of factors by ALL Respondents (Table 9.7 above). This shows Factor 1 <Uncertainty Avoidance and Risk> with 31.317% TVE.

The major policy implications of the above policy analysis, bearing in mind that of the factor analysis, are: (i) GOV Respondents are diametrically opposed to other KNSI Actors (KBIs, ARBs) in their assessment of policy instrument success in overcoming barriers to innovation as VHS-VLC. This implicates that there is a danger that GoK may persist with policies which may be actually unsatisfactory in terms of the coherence of the KNSI; (ii) Apart from policy instrument Research Grants and barrier to innovation 'Rate of Access to ICT' as VHS-VLC ALL Respondents deem policy instruments in relation to variables of barriers to innovation as US-VHC; (iii) Crucial variables that are barriers to innovation, influenced highly significantly by latent factors (to barriers to innovation) which do not appear as VHC implies that, ALL Respondents in assessing policy instruments in relation to variables of barriers to innovation as overwhelmingly US-VHC may be occluded from a view of the efficacy of policy instruments with respect to these crucial variables; (iv) The absence of significant assessment by MHTI Respondents of policy instrument success regarding barriers to innovation, and paucity of assessment by KBIs and ARB Respondents points to their collective lack of knowledge on GoK policies and their effects[105]; (v) There appears a fundamental contradiction on the part of GOV Respondents in that on the one hand they assess the variables under the dimension <<Maladjusted Markets>> as significantly high barriers to innovation, and on the other hand deem that their policy instruments in relation to these very same variables encapsulated by <<Maladjusted Markets>> as VHS-VLC. The GoK appears to have, at best, an unclear appreciation of the efficacity of policy instruments in relation to barriers to innovation and, at worst, is deluding itself; (vi) The primary policy instruments – Government-Backed Venture Capital, Regulation, Government Procurement, and Labour Mobility Laws (Laws and Incentives) – (once reconfigured and recalibrated) are strategically crucial to addressing and overcoming systemic deficiencies in the <<Exiguous Human Capital>> and <<Maladjusted Markets>> [106] of the KNSI[107]; (vii) The primary policy instruments – Subsidised Loans, and Standard Setting – (once reconfigured and recalibrated) are operationally crucial to addressing and overcoming the system-wide <<Excessive Risk>>[108] and <<Regulatory Deficiencies>> within the KNSI; (viii) Three first tier major specific barriers to innovation variables, namely; 'Lack of Finance', 'Lack of Explicit Policy Support', 'Quality of Technically Trained Manpower' need to become targets of policy[109]; (ix) Two second tier specific barriers to innovation, namely 'Organisational Rigidities' and 'Innovation Costs (Too High)' need to become targets of policy attention; (x) Two third tier specific barriers to innovation namely; 'Brain Drain, 'Rate of Access to ICT' and need to become targets of policy[110]; and, (xi) Judicious policy prioritisation and sequencing suggests the following policy timeframe and target with respect to policy instrument recalibration and reconfiguration to overcome barriers to innovation (see Table 9.16 below).

***Table 9.16** – Timeframe for Policy Instruments*

Policy Timeframe	Target	Policy Instruments	Barriers to Innovation
Short-Term (1-3 Years)	KNSI-wide, KBIs, ARBs	Government-backed venture capital, Regulation, Goverment procurement, Labour mobility laws (laws, incentives)	'Lack of Finance', 'Lack of Explicit Policy Support', 'Quality of Technically Trained Manpower'
Medium-Term (3-5 Years)	KNSI-wide, GOV, KBIs MHTI	Subsidised loans, Standard setting	'Innovation Costs (Too High)', 'Organisational Rigidities'
Long-Term (5-10 Years)	KNSI-wide, Economy wide	Subsidised loans, Standard setting, Regulation	'Excessive Perceived Economic Risk', 'Brain Drain', 'Hierarchical Organisations', 'Restrictive Public/Governmental Regulation', 'Rate of Access to ICT', 'ICT Capacity', 'Lack of Technically Trained Manpower'

[105] It is to be recalled that GOV, MHTI, KBIs, ARBs are relatively isolated from one another (See: Fig 9.13, 9.14 above).

[106] Note that 'Lack of Demanding Customers' loads at 0.938 (F2-MHTI).

[107] In the same sense Venture Capital is used innovatively for skills upgrading and nurturing entrepreneurial talent. (Saxenian, 2005; Anderson and Napier, 2007).

[108] Note that 'Excessive Perceived Economic Risk' loads at 0.986 (F1-GOV) and 'Innovation Costs (Too High)' load at 0.806 (F1-MHTI).

[109] While ensuring that the 'Brain Drain' is not exacerbated, it needs recalling that the 'Brain Drain' loads at 0.796 (F1 ALL) and 0.858 (F1-GOV) and is a very significant barrier.

[110] 'Brain Drain' and 'Rate of Access to ICT' load at 0.796 (F1-All), 0.858 (F1-ARB) and 0.875 (F1-KBIs).

The above Table needs to be read as a 'rolling' policy frame of reference which is programmatic, rather than static, and which is consistent with legislative processes of government.

The precondition for policy recommendations to address successfully the poorly configured and inadequately calibrated policy instruments and interventions is anchoring innovation policy more firmly within a strategically coherent industrialisation policy[111] as the heart of overall socio-economic development towards a high income economy.

Five key areas for policy recommendations that are apposite are:

- Towards an innovation driven economy;
- Public procurement and innovation;
- IPRs, Spin-Offs and business incubation;
- STEMIT as the prime drivers of innovation; and,
- Absorbing international knowledge innovation and technology.

With respect to an innovation driven economy, the policy recommendations include: (i) Following the evidence of policy measurement, from mapping and measuring the KNSI develop a customised innovation policy with qualitative and quantitative targets; (ii) Use peer (middle-income country) innovation metrics[112] to track and measure policy progress and effectiveness driven by the application of KNSI longitudinal surveys; (iii) Embedding a culture of innovation across the management of the economy; (iv) Orienting policy to address the key challenges of innovation facing the national economy[113]; and, (v) Creating a departmental unit in the Ministry of Education (Department of KBI Skills and Innovation – (KBISI)) that, along with the SETIRC and the KNSIPU, ensures innovativeness across KNSI Actor behaviour.

With reference to public procurement and innovation, policy recommendations include: (i) Deploying the weight of Government spending power, public procurement and public services demand, to reconfigure the environment for innovation and innovativeness; (ii) Requiring all Government departments to develop an innovation oriented procurement plan for stimulating innovativeness through public spending; (iii) KNSIPU and Department of KBISI to facilitate mobility of private sector personnel into the public sector with respect to innovative procurement practices; (iv) Using Government procurement (central, regional, local) to create 'lead markets' for innovative products and services; (v) Government to have a posture of an 'innovator' and 'early adopter' in the diffusion of innovation paradigm[114]; (vi) Consolidate the array of public procurement Authorities, Agencies, Boards into a centralised Government Procurement Service[115] with a mandate to procure on the basis of innovative solutions; and, (vii) Opening up procurement windows for SMEs in MHTI.

With respect to IPRs, spin offs and business incubation, a forward looking policy posture must recognise that, in the 21st century as international flows of DISK increasingly commoditise information and knowledge (but not tacit aspects of know-how and know-why), there are increasing returns to user-led innovation. Therefore, policy recommendations include: (i) Government, as a monopolistic purchaser of products and services, along with KBIs, to focus on supply-side regarding innovative SMEs in MHTI; (ii) KBIs to be required to create business incubators (for spin offs) into which is fed the results of STEMIT masters, doctoral and post-doctoral research[116]; (iii) Differentiate Government support to entrepreneurship much more finely in terms of fiscal/monetary, managerial and technological levels[117]; and, (iv) Leverage Government-Backed Venture Capital through triangulation with private sector and Arbitrageur funding of incubators.

In keeping with innovation policy as the leading key component of a strategic industrial policy[118], regarding STEMIT as the prime drivers of innovation, STEMIT policy needs to become a central component of economic policy. Policy recommendations include: (i) Stipulating a government target of 3% of GDP to support R&D in STEMIT, then doubling to 6% of GDP within ten years; (ii) Leveraging private R&D expenditure in support of STEMIT through fiscal recalibration, matching funds and direct support; (iii) Requiring all public expenditure on STEMIT programmes to generate patent, licensing and royalty fees as part of Government equity position in support of STEMIT ; (iv) Initiating a specific KBI Innovation Fund to support STEMIT[119] spin-offs from KBI research[120] ; (v) Requiring

[111] The Kenya national Industrialization policy (2010), Kenya Vision 2030.

[112] There are several metrics and methodologies, as well as reports available including from the private sector, the UN, World Economic Forum, World Competitiveness Report, Global Information Technology Report that can guide policy making.

[113] These are: understanding the dynamics of innovation; measuring systemic innovativeness and innovation; ensuring STEMIT curricula emphasise learning skills; Government to lead by example; and make the most of KBIs placing HE and RIs at the core of innovation policy.

[114] With respect to procurement from Ministries of Health, Education, Defense, Trade and Industry, etc. for example.

[115] Such a centralization would provide the necessary economies of scale in procurement commensurate with coherence in maintaining standards.

[116] Such incubators to be linked to MHTI along the policy lines recommended earlier. It is estimated that for the U.S. the number of incubators at approximately 1,200 support about 27,000 businesses and generates about US$ 17 billion annually (Gielen *et al.*, 2013).

[117] Low level fiscal/financial – industrial estates; medium level fiscal/financial, management and technological – business parks and enterprise centres networked with KBIs and MHTI; high level fiscal/financial, management and technological – business and innovation centres, science parks, and technological centres networked (on campus) with KBIs, MHTI and ARB.

[118] See: Goh, Andrew L. S. (2005). "Towards an innovation-driven economy through industrial policy-making: An evolutionary analysis of Singapore." The Innovation Journal: The Public Sector Innovation Journal 10.3: 34.

KBIs to perform entrepreneurially (in an integrated manner) as a KNSI Actor the roles of: undertaking STEMIT research, pedagogy, knowledge transfer (to/from industry), act as national and regional conduits into the global knowledge economy, and lead in the design and delivery of regional economic development strategies, against performance-based targets[121]; (vi) Reorienting education toward life-long learning, particularly in STEMIT and for innovation; and (vii) Adopt a geo-spatial information systems (GSIS) approach to policy-making.

With respect to the KNSI absorbing international knowledge, innovation and technology, because of the global dynamics of innovation, the KNSI needs to develop rapidly an absorptive capacity that enables access to, and diffusion of, innovations from anywhere. Policy recommendations therefore include: (i) Focusing on connecting the urban centres in the super region formed by the parabolic Western - Central Rift Valley – Central – Nairobi – Lower Eastern – Southern Coast[122]; (ii) Requiring KBIs to develop international strategic partnerships[123], as part of conditions for public support, aimed at knowledge, technology and IPR/LPR transfers; (iii) Measuring KBIs on their absorptive capacity[124]; (iv) Requiring KNSI Actors to collaborate as a function of Government support; and, (v) Requiring Government to fund KBI R&D on the basis of inter-disciplinary collaboration and triangulation.

Survey Analysis: Unsuccessful policy instruments and very high constraints on innovativeness and innovation.

Policy Implication: Poorly configured and inadequately calibrated policy instruments and interventions with respect to barriers to innovation.

Policy Recommendation: Reconfiguration and recalibration of policy instruments and interventions towards a performance based support by government.

[119] The GoK can then decide how to manage these fees, for which options could be: (i) remuneration in part (or whole) and (ii) re-investment (in part or whole) in further spin-offs.

[120] The anticipated exports of hydrocarbons starting in 2016 will lead to possibilities for establishing a Kenya Soverign Wealth Fund that can assist with this (See Kenya from nowhere Plans East Africa's First Oil Exports: Energy. Bloomberg Eduard Gismatullin (2013), www. Bloomberg.com

[121] Such as: research evaluation exercises; teaching assessment exercises; patent, licensing, royalty fees; quality of international and regional linkages; and regional development assessment exercises.

[122] See Dunning J., (2000). Regions, Globalization, and the Knowledge-Based Economy Oxford, Oxford University Press.

[123] Limited in number with the emphasis on quality of institutions.

[124] Based on metrics of: access capacity (capacity to spread 'DISK' in the locality and region), DISK creation capacity (capacity to create knowledge), and DISK exploitation capacity (capacity to commercialise IPRs).

9.5.7 Availability of Policy Instruments & Success

Table 9.17 presents the available policy instruments and their success (or otherwise) in promoting innovativeness and innovation[125] in the economy.

Across ALL Respondents (together and separately) the overwhelming assessment, with the exception of GOV Respondents, is that available policy instruments, with the exception of ICT Access are not successful, in promoting innovativeness and innovation . This reflects earlier findings regarding policy instruments and barriers to innovation. As far as ALL Actors are concerned, a sizeable minority ranging from 26.0% to 49.6% assess the policy instruments as very highly successful, however, the vast majority ranging from 54.2% to 73.9% assess the instruments as not successful.

Regarding GOV Actors, again a sizeable minority 12.6% to 46.0% assesses the policy instruments as not successful; however, the vast majority 53.7% to 87.5% assesses the instruments as very highly successful. This reflects the GOV Respondent assessment of success of policy instruments in overcoming barriers to innovation (see Table 9.14) but contradicts the evaluation by other KNSI Actors and all KNSI Actors who deem policy instruments not successful. With MHTI Actors, a respectable minority 24.0% to 43.4% assesses the policy instruments as very highly successful; however, the vast majority 56.8% to 68.0% assesses the instruments as not successful. Regarding KBI Actors, a respectable minority 18.8% to 46.9% assesses the policy instruments as very highly successful; however, the vast majority ranging from 53.0% to 81.0% assesses the instruments as not successful[126]. As far as ARBs are concerned a notable minority 28.0% to 36.0% evaluate policy instruments as very highly successful. In the case of Government Procurement, and ICT Access 68.0% and 56.0% of ARBs deem these instruments as very highly successful. In contrast, 64.0% to 72.0% of ARBs assess policy instruments (with the exception of Government Procurement, and ICT Access) as not successful. The significant results from MHTI and KBIs corroborate that from ALL Respondents and contradict those from GOV.

These significant results confirm that extant policy instruments are not overcoming barriers to innovation, either in terms of the factor barriers to innovation or the variables of innovation. In terms of the ranking of highest majority indicating not successful policy instruments from ALL Respondents and each Actor group one sees: (ALL) Tax Breaks; (GOV) Tax Breaks; (KBI) Subsidised Loans; and (MHTI) Tax Breaks; and (ARBs) Subsidised Loans, Government-Backed Venture Capital, and Standard Setting (72.0% of ARB Respondents judge each to be not successful) (see Table 9.17 below). It is instructive first that two policy instruments; Tax Breaks, and Donor Funds, do not appear significant in Table 9.14 as overcoming barriers to innovation, yet 'Lack of finance' is significantly the most frequently occurring variable barrier to innovation corroborated across Actors as not overcome by policy instruments. Secondly, tax breaks are assessed as the most unsuccessful policy instruments by the majority of

[125] Notwithstanding the biased assessment of GOV Respondents (see Table 9.14 above).

[126] Exceptionally only 39.5% KBI Respondents deem Labour Mobility (Laws Incentives) not successful.

Table 9.17 – Success of Policy Instruments

Success of Policy Instruments										
	All Actors %		GOV Actors %		MHTI Actor %		KBIs %		ARB Actor %	
Policy Instrument	**VHS**	**NS**	**VHS**	**NS**	**VHS**	**NS**	**VHS**	**NS**	**VHS**	**NS**
Research Grants	49.6	50.3	87.5	12.6	43.4	56.8	46.9	53.0		
Tax Breaks	26.0	73.9	53.7	46.0	32.0	68.0	18.8	81.0	32.0	68.0
Subsidised Loans	33.5	66.6	76.9	23.1	39.6	60.4	25.6	98.3	28.0	72.0
Government Backed Venture Capital	31.4	68.7	80.8	19.0			26.3	73.8	28.0	72.0
Donor Funds	45.9	54.2			39.6	60.4	43.8	55.9	36.0	64.0
Government Procurement	26.6	73.6					19.4	80.5	68.0	32.0
Standard Setting	34.7	65.3					28.7	71.3	28.0	72.0
Regulation	38.8	61.2					34.7	65.3		
Labour Mobility Law (laws, incentives)	29.5	70.4	69.1	23.0	34.0	66.1	29.1	39.5	32.0	68.0
ICT Access	54.8	45.0			51.0	49.2			56.0	44.0

ALL and MHTI[127]. Thirdly, ARB Respondents (72.0%) assess Subsidised Loans as not successful. Clearly the fiscal, financial and monetary incentives associated with the KNSI are deemed as not being adequate in addressing the poor performance of the KNSI. Policy instruments available to the GoK appear blunt, inappropriately calibrated and misconfigured to deal with barriers to innovation.

The policy implications reflect those of the previous section on success (or otherwise) of policy instruments and barriers to innovation but nuanced by the following: (i) Fiscal and monetary policy instruments need reconfiguring and recalibrating, consistent with WTO non-actionable subsidies[128], in order to accelerate innovativeness and innovation; (ii) The policy instruments that require most urgent reconfiguration and recalibration to address and overcome barriers to innovation are: Fiscal (Tax Breaks) arrangements (to enable economy-wide innovativeness and innovation by, for example, altering capital depreciation regulations), Subsidised Loans (to enable KBI to engage in patenting, incubating new ideas, spin-offs from IPRs, generating medium-and high-tech SMEs within university campuses, engaging with MHTI for R&D and product development, earning license and royalty fees, and full-blown commercialisation of research outcomes), and Government-Backed Venture Capital (to engender innovativeness and innovation in the private sector)[129]. The GoK would need to articulate powerfully the argument that a designated proportion of all Donor Funds and Overseas Development Aid (ODA) funding, as well as loans from the Bretton Woods Institutions (BWI), be directed, through a fund for innovation, to support SMEs in MHTI and KBIs in triangulation with ARBs to enhance their innovation performance.

The policy recommendations to address clearly unsatisfactory policy instruments include: (i) R&D tax credits, as an incentive for business R&D rates of relief to be adjusted upwards for SMEs in MHTI[130]; reductions in the wage taxes of R&D personnel in KBIs and MHTI (especially SMEs in MHTI); (ii) Initiating a STEMIT research tax incentive programme; (iii) Initiating a competitive STEMIT business scholarship programme for post-graduate and post-doctoral researchers to commercialise their research[131]; (iv) Reconfiguring and recalibrating tax treatment of share options in spin-offs and start-ups to attract experienced managers; (v) Using Government-Backed Venture Capital to guarantee loans[132]; and, (vi) Recoding the inward FDI regime to require the investor to invest (Equity, Joint Ventures) in SMEs in MHTI, as part of the conditionalities for market entry in exchange for fiscal advantages available to the investor.

[127] Even 46.0% of GOV Respondents make this evaluation.

[128] See WTO (1994). Agreement on Subsidies and Countervailing Measures. Identification of Non-Actionable Subsidies, part IV, art. 8.

[129] A remarkable example of this type of policy intervention is the Israeli venture capital industry. Initiated in the 1960s with US$2.5 million government funding, disbursements totaled US$300 million by 1997 and the total value of the funds were US$ 12.2 billion by 2008. (Avnimelech, 2009; Avnimelech and Teubal, 2003).

[130] Rates of relief at 175% for SMEs are not uncommon in countries with a high priority on innovation (See Innovation Nation, March 2008, Cm7345, UK Government).

[131] See The Vanier Canada Graduate Scholarship Programme (www.vanier.gc.ca).

[132] As sunk costs of start-ups and R&D are higher than for ordinary investment in capital machinery.

Survey Analysis: Extant policy instruments and their operations are unsuccessful in overcoming barriers to innovation.

Policy Implication: Need to recalibrate fiscal and monetary policies to make Tax Breaks, Government-Backed Venture Capital, and Subsidised Loans effective.

Policy Recommendation: Lower taxes for R&D personnel and activities.

9.5.8 Latent Factors to Policy Success

The policy analysis of success (or failure) of policy instruments in relation to barriers to innovation indicates the shortfalls and where attention should be focused in the KNSI in order to remove asymmetries, rebalance the system toward improved strategic coherence, and an effective and efficient operational performance.

A prioritisation of the policy instruments that require recalibration to the needs of specific Actors, and the KNSI as a whole, has been presented. The factors that influence the policy instruments are identified in order to present the recalibration requirements. These are presented in the following tables (Table 9.18, 9.19, 9.20, 9.21 and 9.22):

***Table 9.18** – Latent Factors to Policy Success (ALL)*

Factor Number	Name of Factor	Variables	Factor Loading	Cronbach's Alpha	Total Variance Explained	KMO	Bartlets Test of Sphericity		
							Chi Squared	Df	Significance
1	ICT Regulatory Standards-based Support	ICT Access	0.921	0.921	64.847	0.931	2026.021	45	0.000
		Regulation	0.918						
		Standards Setting	0.860						
		Donor Funding	0.765						
		Research Grants	0.706						
		Government Procurement	0.638						
		Labour Mobility (laws, incentive)	0.674						
2	Monetary & Fiscal Incentives	Subsidised Loans	0.953	0.894	8.471				
		Tax Breaks	0.900						
		Government Backed Venture Capital	0.618						
				Cumulative Total	**73.434**				

Residuals are computed between observed and reproduced correlations. There are 16 (35.0%) non-redundant residuals with absolute values greater than 0.05.

***Table 9.19** – Latent Factors to Policy Success (Government)*

Factor Number	Name of Factor	Variables	Factor Loading	Cronbach's Alpha	Total Variance Explained	KMO	Bartlets Test of Sphericity		
							Chi Squared	Df	Significance
1	Regulatory Standards-based State Support	Regulation	0.908	0.919	63.784	0.842	184.669	45	0.000
		Standards Setting	0.896						
		Government Procurement	0.865						
		Research Grants	0.810						
		Labour Mobility (laws, incentives)	0.702						
		ICT Access	0.674						
2	Fiscal & Monetary Incentives	Tax Breaks	0.950	0.875	10.579				
		Subsidised Loans	0.803						
		Donor Funds	0.700						
		Government Backed Venture Capital	0.591						
				Cumulative Total	**74.363**				

Residuals are computed between observed and reproduced correlations. There are 26 (57.0%) non-redundant residuals with absolute values greater than 0.05.

Table 9.20 – *Latent Factors to Policy Success (Medium and High-Tech Industry)*

Factor Number	Name of Factor	Variables	Factor Loading	Cronbach's Alpha	Total Variance Explained	KMO	Bartlets Test of Sphericity		
							Chi Squared	Df	Significance
1	Fiscal & Monetary Incentives	Tax Breaks	1.005	0.951	71.371	0.911	519.815	45	0.000
		Subsidised Loans	0.931						
		Government Backed Venture Capital	0.898						
		Government Procurement	0.807						
2	Externally Funded Regulatory Support	Donor Funds	0.979	0.914	8.280				
		Regulation	0.878						
		ICT Access	0.674						
		Standards Setting	0.628						
		Labour Mobility (laws, incentives)	0.577						
				Cumulative Total	**79.597**				

Residuals are computed between observed and reproduced correlations. There are 21 (46.0%) non-redundant residuals with absolute values greater than 0.05.

Table 9.21 – *Latent Factors to Policy Success (Knowledge-Based Institutions)*

Factor Number	Name of Factor	Variables	Factor Loading	Cronbach's Alpha	Total Variance Explained	KMO	Bartlets Test of Sphericity		
							Chi Squared	Df	Significance
1	Standards-based ICT Regulatory Support	Standards Setting	0.889	0.889	58.254	0.898	1048.362	45	0.000
		Regulation	0.883						
		ICT Access	0.872						
		Donor Funds	0.716						
		Research Grants	0.675						
		Government Procurement	0.664						
2	Monetary & Fiscal Incentives	Subsidised Loans	0.975	0.876	10.720				
		Tax Breaks	0.922						
		Government Backed Venture Capital	0.630						
				Cumulative Total	**68.974**				

Residuals are computed between observed and reproduced correlations. There are 20 (44.0%) non-redundant residuals with absolute values greater than 0.05

Table 9.22 – *Latent Factors to Policy Success (Arbitrageurs)*

Factor Number	Name of Factor	Variables	Factor Loading	Cronbach's Alpha	Total Variance Explained	KMO	Bartlets Test of Sphericity		
							Chi Squared	Df	Significance
1	External & Internal State Support	Donor Funds	1.064	0.897	72.896	0.802	250.021	45	0.000
		Research Grants	0.791						
		Government Procurement	0.679						
2	ICT & Human Capacity Mobility	ICT Access	0.977	0.891	8.002				
		Labour Mobiltiy (laws, incentives)	0.599						
		Tax Breaks	0.598						
3	Monetary Incentives	Subsidised Loans	0.981		5.399				
				Cumulative Total	**86.298**				

Residuals are computed between observed and reproduced correlations. There are 12 (26.0%) non-redundant residuals with absolute values greater than 0.05.

The above tables present the factors that influence significantly policy instruments with respect to dynamism of the KNSI. Close scrutiny of factors influencing policy instruments, from each Actor's perspective, shows that direct support either in terms of monetary and fiscal support or state support is seen as a means to galvanise the effective and efficient performance of the KNSI. From ALL Respondents, two factors emerge, namely, Factor 1 <ICT Regulatory Standards-Based Support> and Factor 2 <Monetary & Fiscal Incentives>. Factor 1 accounts for 64.847% of total variance explained and is approximately 7.5 times more powerful than Factor 2.

For GOV Respondents Factor 1 <Regulatory Standards-Based State Support> accounts for 63.784% of TVE, and Factor 2 <Fiscal & Monetary Incentives> counts for 10.579% of the TVE. Factor 1 is approximately six times more powerful than Factor 2. In examining Factors 1 and 2, it can be appreciated that GOV Respondents assess direct interventions as more crucial in comparison to incentives.

For MHTI Respondents, Factor 1 <Fiscal & Monetary Incentives> accounts for 71.371% of TVE and is responsible for 100% of the variation of the variable 'Tax Breaks', and 86.7% of the variation of the variable 'Subsidised Loans' in the sample and population. Factor 1 is about seven times more powerful than Factor 2 <Externally Funded Regulatory Support>. With respect to Factor 2 and 1, GOV and MHTI respectively, the assessment of policy success factors are convergent.

For KBI, Factor 1 <Standards-Based ICT Regulatory Support> accounts for 58.254% of TVE and is responsible for 79.0%, 78.0% and 76.0% of the variation of the variables 'Standards Setting', 'Regulation' and 'ICT Access' respectively in the sample and population. Factor 1 is nearly five times more powerful than Factor 2 <Monetary & Fiscal Incentives>.

Finally, for ARB, Factor 1 <External & Internal State Support> accounts for 72.896% of TVE and is responsible for 100%, 62.6% and 46.1% of the variation of the variables 'Donor Funds', 'Research Grants' and 'Government Procurement' in the sample and population. Factor 1 is nearly seven and 14 times more powerful than Factor 2 <ICT & Human Capacity Mobility>, and Factor 3 < Monetary Incentives>, respectively.

From each of the individual Actor's assessment, respectively, Factor 1 far outweighs the other factors. Such a view of Factor 1 across KNSI Actors permits a focus on policy implications and recommendations.

The policy implications that arise are: (i) Two key dimensions of policy craft, <<Regulatory>> and <<Financial>>, conform the successful combination of policy instruments in terms of fiscal, monetary, regulation, standards and performance requirements[133]; (ii) <Monetary and Fiscal Support> and its permutations (according to KNSI Actors) directed to the Actors in the KNSI need to be reconfigured and recalibrated in the light of the systemic failure of policy instruments identified above; (iii) <ICT Regulatory Standards-Based Support> and its permutations (according to KNSI actors) require reconfiguration and recalibration in order to sustain, and accelerate the performance of the KNSI; (iv) In return for providing explicit, enshrined in law, support Government would need to demand that KNSI Actors meet performance requirements that are encouraged by incentives and sanctions; (v) A judicious policy mix of direct and indirect support measures are requisite, (vi) The fiscal and monetary regime relevant to innovation and innovativeness would need to be audited for 'fitness-for-purpose' with respect to the KNSI; and, (vii) Regulatory support to innovation in general and to the KNSI specifically would need to be audited for 'fitness-for-purpose'.

The policy recommendations to support the <<Regulatory>> and <<Financial>> dimensions of policy success include: (i) Selecting a mix of newly reconfigured and recalibrated financial instruments (backed to differing extents by Government)[134]; (ii) Selecting a mix of tax incentives[135]; (iii) Using a sovereign wealth fund (expected from future hydrocarbon revenues) to support direct financial interventions on a massive scale; (iv) Selecting a mix of demand-side instruments (public procurement, standards setting, regulations, lead markets) to drive policy success[136]; (v) Adopting regulations, especially environmental, that use performance and technology based rules; (vi) Adopting regulatory incentives for incremental improvements; and, (vii) Setting higher resolution standards oriented toward consumer protection.

Survey Analysis: Policy success is determined by a judicious mix of direct and indirect measures.

Policy Implication: Reconfiguration and recalibration of policy instruments towards performance based measures.

Policy Recommendation: Audit the current policy mix for fitness-for-purpose.

[133] This is consistent with the empirics of financing innovation (OECD, 2005).

[134] Loans, grants, subsidies, venture capital, tax incentives to be applied differently to the Actors in the KNSI in order for the KNSI to meet specific targets and performance indicators in time and space.

[135] R&D tax allowance (concession to a percentage of R&D expenditure), payroll tax credit (reduction in rate of tax), differentiation between large MHTI and SMEs in MHTI firms with SMEs benefitting disproportionately from R&D tax incentives, and targeting of incentives (for example triangulation, start-ups) to be applied to different Actors across the KNSI in meeting their specific performance targets.

[136] This would be accompanied by a strictly reinforced rewards and sanctions regime that seriously encourages KNSI Actors to perform.

9.5.9 Effectiveness and Efficiency of the KNSI

This next section analyses the contextual determinants of innovation, regarding the effectiveness and efficiency of the KNSI, which are represented respectively by the dependent variables: level of innovativeness of business enterprises; and the strength of the linkages between research institutes and the production system[137], and an array of independent variables of the NSI environment. The effectiveness and efficiency of the KNSI is estimated using 80 independent variables in nine categories. The models have one criterion variable each which measure: the effectiveness of NSI as the level of innovativeness of business enterprises; and the efficiency of NSI as the strength of the linkages between research institutes and the production system .

We present an Ordinary Least Squares (OLS) regression analysis of the two different models used to measure the effectiveness and efficiency of the KNSI. Beside OLS estimates, we regress the same models by adding the option of robust standard errors and test for the robustness of the results with respect to the composition of the sample by re-estimating the relationship with a robust regression technique – the iteratively reweighted least squares(IRLS)[138] – which tests for the impact of outliers. This provides higher levels of confidence to the policy analysis, its implications and the resulting policy recommendations. We discuss those variables that influence the independent variables at the 5% and 1% level of significance across techniques[139].

9.5.9.1 Effectiveness of the KNSI

In the first model, we evaluate effectiveness of the KNSI as the level of innovativeness of business enterprises. The model[140] is:

1. (Level of BEs Innovativeness[141]) i = C+ (Importance of the Actors) i * β_1 + (Linkages among the Actors) i * β_2 + (Number of Tertiary Graduates) i * β_3 + (RI Linkages to Production) i * β_4 + (Diffusion of ICT) i * β_5 + (Success of Policy Instruments) i * β_6 + (Barriers to Innovation) i * β_7+ (Governance Innovativeness) i * β_8 + e i .

The dataset is composed of 268 observations for Kenya. Missing data is substituted by the mode – "mode as the 'central tendency' because the arithmetical manipulations required to calculate the mean (…) are inappropriate for ordinal data" (Jamison, 2004).

Table 9.23 presents the effectiveness of the KNSI (level of innovativeness of BEs in Kenya) and shows the variables significantly associated with the dependent variable across techniques at 1% and 5% level of significance.

***Table 9.23** - Effectiveness of the KNSI (Level of Innovativeness of Business Enterprises in Kenya)*

Effectiveness of KNSI (Level of Innovativeness of Business Enterprises in Kenya)			
	(1)	**(2)**	**(3)**
Estimation Method	**OLS**	**OLS (robust SE)**	**Iteratively reweighted least squares**
BEs linked to BEs	0.2327**	0.2327**	0.2750***
	(0.0149)	(0.0190)	(0.0050)
Linkages between RIs and the PS	0.1494**	0.1494**	0.1646**
	(0.0313)	(0.0359)	(0.0206)
Constant	1.2288***	1.2288***	1.3604***
	(0.0084)	(0.0059)	(0.0044)
N	268	268	268
R-sq	0.5653	0.5653	0.5668
Prob › F	0.0000	0.0000	0.0000

p-values in parentheses * p‹0.10 ** p‹0.05 *** p‹0.01

[137] The dependent factors are categorical variables, with values ranging from 1 to 5, where 1 corresponds to a very high level of innovativeness of BEs; and to a very strong level of the linkages between research institutes and the production system, whereas 5 corresponds to a very low level of innovativeness of BEs; and to a very weak level of the linkages between research institutes and the production system.

[138] Iteratively reweighted least squares is a robust regression technique, which assigns a weight to each observation, with lower weights given to outliers.

The R-squared equals 0.5653 and 0.5668 in the OLS (and robust OLS) and IRLS, respectively. This indicates that independent variables explain from 56.53% to 56.68% of the variability of the level of innovativeness of BEs in the sample and hence the population and universe of the KNSI.

The results in Table 9.24 indicate that, in Kenya, BEs inter-Linkages and the linkages between RIs and the production system are significantly associated with the level of innovativeness of BEs.

In Kenya, the linkages between RIs and the production system and in and among BEs are positively associated with the dependent variable level of innovativeness of BEs, indicating that these Actor Linkages are critical factors for the ability of business enterprises to innovate. However, it needs recalling that: (i) 68.2% of ALL Respondents assess that there are very low levels of innovativeness of BEs; (ii) 56.3% assess that RI-BE linkages are very weak and that there is a very low level of innovativeness of BEs; (iii) BEs have no significant linkages with KBIs (HE and RIs) and *vice versa* (See Figures 9.5, 9.7 and 9.8 above); and, (iv) From an Actor-centric perspective, KBIs (HE and RI) have neither proactive, nor passive, inter-linkages with MHTI (BEs) and *vice versa* (see Figure 9.13 above). These findings attest to the fact that the industrial structure of inputs-outputs in relation to domestic dynamism, logistics[142], and supply and value-chains, are inefficient with high transaction costs (Bigsten *et al*., 2010).

Table 9.24 presents the relative Pratt indexes of the significant predictor variables. The table indicates which variables, significantly associated with the level of innovativeness of business enterprises, are relatively important in the linear regression model.

All the predictors meet the condition di>1 / 2 p, and account for a percentage of the R-squared. The linkages among business enterprises account for 11.06% of the R-squared, whereas those between research institutes and the production system account for 9.53% of the goodness of fit.

Given trade-offs, policy options open to resource constrained policy makers in Kenya emerge from a judicious ranking of the significantly influential variables and a view of the weight of the variables in the regression dynamics. The IRLS regression provides the two most significant and descending rank order beta coefficients of the variables: BEs-BEs linkages and RIs-PS linkages. The associated relative Pratt index (IRLS) discloses the same descending rank order as: BEs-BEs linkages and RIs linkages to the production system. Thus, we construe the equation representing the effectiveness of the KNSI as:

2. (Level of Innovativeness of BEs) = 1.3604 + 0.2750 * (BEs-BEs) + 0.1646 * (RIs-PS).

Therefore, in Kenya a 1% increase in the strength of BEs-BEs inter-linkages is associated with a 0.28% increase in the level of innovativeness of business enterprises. Likewise, a 1% increase in the strength of the linkages of RIs with the Production System is associated with a 0.17% increase in the level of innovativeness of BEs. The policy implications of strengthening BE-BE linkages are that there is a greater ability to tap into and exploit stocks and flows of knowledge within the MHTI Actor group, thus increasing the effectiveness of the NSI. Additionally, through the strengthening of RIs-PS linkages there would be greater externalities from the public goods of funding RI[143]. Policy advisory choices suggest that, strengthening Actor Linkages (BEs-BEs and RIs-PS) is the best option in Kenya, although their intensification carries transactions costs of coordination and controlling managerial utility. Specifically, policy recommendations for increasing BEs-BEs and RIs-PS include: (i) Enabling logistics quality and competence to increase by 'atomising' the competition for logistics on the back of critical improvements in infrastructure; (ii) GoK support to KBIs (HE and RI) to be increasingly contingent on performance requirements of; triangulation with MHTI (BEs) and ARBs, KBIs generating IPRs from R&D in STEMIT to be intermediated to MHTI (BEs) by ARBs, and RIs to be required to seek an increasing proportion of their

[139] The data arise from five-point Likert scale measures. Likert data are often used in OLS regression analysis. However, estimating and analysing continuous relationships with ordinal categorical measures implies a measurement problem since the degree of association (i.e. R-squared) and the estimated relationships between the criterion variable (i.e. Y) and the predictors (i.e. Xs) differ when continuous or Likert scale variables are used (Owuor, 2001). Indeed, when variables are Likert scale points, the implicit assumption of the linear regression model that the dependent variable (i.e. Y) is continuous is violated. Nevertheless, ordinal categorical data, or Likert scale data, can be considered as continuous data with equal accuracy and as linear monotonic transformations of the underlying continuous variables, which enables us to analyze Likert scale variables as continuous factors (Labowitz, 1961, 1970, 1971, 1972, 1975)]. Owuor (2003) shows that the mean percent bias of R-squared is asymptotic at the four-point Likert scale and beyond and demonstrates the robustness of the relative Pratt index to Likert scale data conditions. Since our data is based on a five-point Likert scale, first we assume insubstantial underestimation of the R-squared and second we use the relative Pratt index as control.

[140] As a matter of formality, we present the 8 categories as vectors. They are n x k matrices, where n is the number of observations and k is the number of variables that are used to express the category singularly. In this way the beta coefficients, as reported in the model, are k x 1 vectors.

[141] Defined as the extent to which an agent is relatively earlier to adopt than others (Rogers, 1983).

[142] According to World Bank Global Rankings of the logistics performance index (LPI) since 2007 Kenya has ranked poorly at 76/153 (2007), 99/158 (2010), 122/158 (20120, and 74/163 (2014) See: www.pli.worldbank.org/internationa/global/2014 [Accessed October 15th 2014].

[143] To test if the variables are truly important and robust in explaining the level of BEs innovativeness and to assess their significance is only due to inclusion of other predictors, we regress the level of BEs innovativeness only on the significant variables expressed in equation (2). The results (not presented) show that all the independent variables are significantly (at 1% level) correlated to the level of BEs innovativeness.

funds from MHTI (BEs); (iii) GoK support to R&D intense MHTI (BEs) to be increasingly oriented to enabling BEs to use KBIs (HE and RIs) in their innovative activities[144] through changes to the tax system to enable write-offs against R&D contracted to KBIs for example; and (iv) GoK supporting BEs in standing conferences involving businesses and industry associations and chambers of commerce.

***Table 9.24** - Relative Pratt index associated with predictor Xi[145] (effectiveness of the KNSI).*

Relative Pratt index d_i associated with predictor X_i (effectiveness of the KNSI)			
Variable	**Significant**	**Relative Pratt Index OLS**	**Relative Pratt Index IRLS**
BEs linked to BEs	Yes	0.0939	0.1106
Linkages between RIs and the PS	Yes	0.0867	0.0953

Survey Analysis: The level of innovativeness of BEs depends on linkages in and among BEs and between RIs and the production system indicating that these particular Actor linkages are critical factors in the ability of business enterprises to innovate.

Policy Implication: Without BEs-BEs and RIs-PS linkages the effectiveness (and innovativeness) of the KNSI is hobbled.

Policy Recommendation: Ensure triangulation between BEs, RIs and MHTI through performance requirements with respect to fiscal and monetary incentives for example.

9.5.9.1 Efficiency of the KNSI

By analysing the second model, we capture the efficiency of the KNSI as the relationships between the independent variables and the strength of the linkages between research institutes (RI) and the production system (PS). The model[146] is:

3. (RI Linkages to Production) i = C+ (Importance of the Actors) i * β_1 + (Linkages among the Actors) i * β_2 + (Number of Tertiary Graduates) i * β_3 + (Diffusion of ICT) i * β_4 + (Level of BEs Innovativeness) i * β_5 + (Success of Policy Instruments) i * β_6 + (Barriers to Innovation) i * β_7 + (Governance Innovativeness) i * β_8 + e i.

In Table 9.25 we present the significant coefficients of the critical factors that determine the efficiency of the KNSI proxied by the strength of the linkages between research institutes and the production systems in Kenya.

As indicated in Table 9.25, the independent variables explain the 56.34% to 72.73% of the variability of the dependent variable in the regressions. The results indicate that the model is significantly different from zero (Prob > F = 0.0000).

Actor Linkages are positively associated with the dependent variable: linkages between research institutes and the production system. In particular, the inter-linkages among research institutes are highly and positively associated with the criterion variable as are the linkages between business enterprises and arbitrageurs. These results are robust. Also the level of innovativeness of business enterprises is significantly and positively associated with the linkages between research institutes and the production system. Thus, the more innovative BEs are, the greater the strength of the linkages, and *vice versa.*

Unexpectedly, the linkages between the Government and Arbitrageurs, and between Arbitrageurs and Research Institutes, are negatively associated with the strength of the linkages between Research Institutes and the production system. The absolute value of the latter relationship is much higher than the absolute value of any other association in the model although it decreases when applying the robust technique (IRLS). At first sight this might appear counter-intuitive. However, on reflection, the regression equation suggests that firstly, lower (or weaker or less intense) RIs-PS linkages are associated with (the need for) higher (or stronger or more intense) linkages between the Government and Arbitrageurs in order to support the efficiency of the KNSI. And *vice versa*, the higher (or stronger or more intense) the linkages between RIs and the PS the lower (or weaker or less

[144] See Laursen, K., and Salter, A. (2004). Searching high and low: what types of firms use universities as a source of innovation? Research Policy, 33(8), pp.1201-1215.

[145] To test if the variables are truly important and robust in explaining the level of BEs innovativeness and to assess their significance is only due to inclusion of other predictors, we regress the level of BEs innovativeness only on the significant variables expressed in equation (2). The results (not presented) show that all the independent variables are significantly (at 1% level) correlated to the level of BEs innovativeness.

[146] As a matter of formality, we present the 8 categories as vectors. They are n x k matrices, where n is the number of observations and k is the number of variables that are used to express the category singularly. In this way the beta coefficients, as reported in the model, are k x 1 vectors.

***Table 9.25** - Efficiency of the KNSI (Linkages between Research Institutes and the Production System in Kenya)*

Efficiency of the KNSI (Linkages between Research Institutes and the Production System in Kenya)			
Estimation Method	**OLS**	**OLS (robust SE)**	**Iteratively reweighted least squares**
GOV linked to ARBs	-0.1791**	-0.1791**	-0.2064***
	(0.0435)	(0.0404)	(0.0058)
RIs linked to RIs	0.2411**	0.2411**	0.3080***
	(0.0195)	(0.0112)	(0.0004)
BEs linked to ARBs	0.2756***	0.2756***	0.1644**
	(0.0020)	(0.0023)	(0.0272)
ARBs and FIs linked to RIs	-0.2958***	-0.2958***	-0.1999**
	(0.0062)	(0.0043)	(0.0269)
Level of innovativeness of BEs	0.1643**	0.1643**	0.1506**
	(0.0313)	(0.0261)	(0.0189)
Constant	0.7549	0.7549	0.2902
	(0.1249)	(0.1621)	(0.4812)
N	268	268	268
R-sq	0.5634	0.5634	0.7273
Prob › F	0.0000	0.0000	0.0000

p-values in parentheses * p ‹ 0.10 ** p ‹ 0.05 *** p ‹ 0.01

intense) the need for Government and Arbitrageurs linkages as the NSI is robust and functioning well. Secondly, lower (or weaker or less intense) RIs-PS linkages are associated with (the need for) higher (or stronger or more intense) linkages between Arbitrageurs and Research Institutes in order to support the forward integration of RIs towards industry and the market. And *vice versa*, the higher (or stronger or more intense) the linkages between RIs and the PS the lower (or weaker or less intense) the need for Arbitrageurs and Research Institutes linkages, as the RIs are well served from the perspective of intermediation.

As each NSI is structurally different, the benefits of individually mapping and measuring each NSI comes to the fore when in comparative analysis we see that interestingly, in comparison to the Ghana NSI, in the KNSI the diffusion of ICT and the rate of access to ICT are not significantly associated with the dependent variable the linkages between Research Institutes and the production system. However, as in the case of the Ghana NSI, the level of innovativeness of BEs is significantly associated with the strength of the linkages between RIs and the production system.

Table 9.26 presents results for the relative Pratt indices. All the significant variables – RIs-RIs and BEs-ARBs inter-linkages and the level of innovativeness of BEs – are important among the set of predictors in the regression models, expect GOV-ARBs and ARBs & FIs-RIs inter-linkages predictors.

Actors Linkages (RIs-RIs and BEs-ARBs) respectively account for 8.47% and 6.98% of the R-squared, whereas the relative Pratt index of the level of innovativeness of BEs variable is equal to 6.79%, thereby indicating which proportion of the model goodness of fit attributable to the variable.

The descending order ranked IRLS regression independent variables are: RIs-RIs inter-linkages; GOV-ARBs inter-linkages; ARBs & FIs-RIs inter-linkages; BEs-ARBs inter-linkages; and level of innovativeness of BEs. The associated relative Pratt index discloses in descending order rank as: RIs-RIs and BEs-ARBs inter-linkages and level of innovativeness of BEs. We construct the equation as:

4. (Strength of RIs-production system linkages) = 0.2902 + 0.3080 * (RIs-RIs linkages) - 0.2064 * (GOV-ARBs linkages) - 0.1999 * (ARBs & FIs-RIs linkages) + 0.1644 * (BEs-ARBs linkages) + 0.1506 * (Level of BEs Innovativeness).

From a policy perspective, a 1% increase in Actor Linkages' strength (RIs-RIs and BEs-ARBs) is respectively related to a

Table 9.26 - *Relative Pratt index di associated with predictor Xi (Efficiency of the KNSI).*

Relative Pratt index d_i associated with predictor X_i (Efficiency of the KNSI)			
Variable	**Significant**	**Relative Pratt Index OLS**	**Relative Pratt Index IRLS**
GOV linked to ARBs	Yes		
RIs linked to RIs	Yes	0.0856	0.0847
BEs linked to ARBs	Yes	0.1512	0.0698
ARBs and FIs linked to RIs	Yes		
Level of innovativeness of BEs	Yes	0.0957	0.0679

0.31% and 0.16% increase in the strength of the linkages between RIs and the production system. A 1% increase in level of BEs innovativeness is associated with a 0.15% in the dependent variable – the strength of the linkages between RIs and the production system. A 1% reduction in GOV-ARBs and ARBs & FIs-RIs inter-linkages are respectively associated with a 0.21% and 0.20% increase in the dependent variable strength of RIs-production system linkages.

In the case of Kenya, the policy implications are oriented around the strengthening of Actor linkages. Specifically, the enhancement of the inter-linkages among RIs and between Business Enterprises and Arbitrageurs would improve the efficiency of the NSI. The policy implications of strengthening RIs-RIs linkages are that there is a greater ability to tap into and exploit stocks and flows of knowledge within the group, thereby enhancing the efficiency of the NSI[147]. Specifically policy recommendations for targeting the determinants of efficiency of the KNSI include: (i) Applying performance requirements to KBIs (HE, RIs) to formalise inter-linkages, with output KPIs, through co-research, joint applications (maximum three consortia) for research grants, consortia for Government tendering, and standing biennial conferences with MHTI for exhibiting IPRs; (ii) Establishing a central IPR office for RIs; (iii) Conditioning all research awards and grants on the production and commercialisation of minimum three IPRs; (iv) Condition research awards and grants to RIs on at least one incubated spin-off; (v) Condition Government direct and indirect support to KBIs, FIs and VC on triangulation ARBs-KBIs-MHTI; (vi) Ensure ARBs representation on KNSIPU; (vii) Legislate formal consultation by Government with FIs and VC on policy matters concerning the KNSI; (viii) Use Government controlled VC and development bank facilities to triangulate with ARBs and RIs; (ix) Mandate Government controlled VC to stipulate a percentage of portfolio for RIs incubated spin-offs; (x) Instigate performance requirements concerning research and grants, part of which should be matched by funds from ARBs with respect to output IPRs and spin-off commercialisation; (xi) Use fiscal regime to increase BE-ARBs inter-linkages by allowing write-offs against commercialisation of KBI(HE, RI) IPRs by BEs, part funded by ARBs; (xii) Alter depreciation rates to permit accelerated capital for labour substitutions; (xiii) Use fiscal and monetary incentives to accelerate the rate of skills upgrading in MHTI BEs; (xiv) Condition direct and indirect support to MHTI BEs on KBI (HE RIs) subcontracted by MHTI BEs for a percentage of the product development portfolio; (xv) Condition direct and indirect support to MHTI BEs on their sponsoring specific RIs; and (xvi) Reconfigure the inward FDI regime to require investors to formalise joint ventures with RIs.

Survey Analysis: Strength of RIs-production system linkages is determined by Actor intra- and inter-linkages and level of innovativeness in BEs.

Policy Implication: Without Actor intra- and inter-linkages and innovativeness of BEs the efficiency of the KNSI is hobbled.

Policy Recommendation: Increase RIs-RIs linkages and BEs-ARBs linkages while judiciously managing GOV-ARBs linkages and ARBs & FIs-RIs linkages in the light of KNSI efficient performance to avoid regulatory capture and ensuring increasing independent RIs more able to 'go to market' on their own.

[147] To test if the above-mentioned variables are truly significant and robust, linkages between RIs and the production system is regressed only on the significant variables expressed in equation (4). From the results (not presented) we deduce that only RIs-RIs and ARBs & FIs-RIs inter-linkages, and the level of BEs innovativeness are significantly associated with the linkages between RIs and the production system.

10.0 Policy Recommendations Matrix

Policy Implication	Specific Implications	Policy Recommendations
Research Institutions' Linkages with the Production System and Level of Innovativeness of Business Enterprises		
Little if any positive externalities from the public goods of funding RIs.	i. There are at best few, and at worst no positive externalities arising from the expenditure and public goods in supporting RIs; ii. The signalling mechanisms by which RIs respond to the market on the one hand, and on the other hand, the production system and BEs make demands on RIs are at best intermittent, and at worst dysfunctional; iii. The marketing and sales orientation of RIs with respect to their stock of intellectual property is insular and hence inappropriate, and therefore exploitation of their knowledge assets is very limited; iv. The flows of intellectual property from RIs to the production system are truncated; and, v. The potential for RIs to earn patent, license and royalty fees from intellectual property rights are largely unrealised.	i. Reform of governance in RIs (and by implication KBIs) to enhance excellence in research based on performance measures tied to the funding of RIs and KBIs; ii. Shift funding of RIs and KBIs to performance-based funding as a function of RIs and KBIs engagement with MHTI in terms of collaborative research, product development, licensing, patent and royalty fees (LPRs), and provision by RIs and KBIs of technological development services to MHTI; iii. Re-orient the funding of RIs and KBIs toward competitive grants tied to RIs and KBIs – MHTI relationships; iv. Require RIs and KBIs to create intellectual property rights (IPRs) management offices mandated to patent IP and funded on performance, for example, on in-coming LPRs; v. Require science, technology, engineering, mathematics and information technology (STEMIT) post-graduate, doctoral and post-doctoral studies competitively funded by government scholarships to be embedded in a MHTI firm; vi. Selectively condition fiscal and monetary incentives available to MHTI to the hiring of STEMIT post-graduates and embedding of post-graduate, doctoral and post-doctoral studies; vii. Allow RI and KBI researchers to exploit discoveries commercially through amended contract conditions and career development paths that require such performance; viii. Increase the management autonomy of RIs and KBIs and the autonomy of their relationships to MHTI; ix. Require boards of RIs and KBIs to include CEOs from MHTI; x. Set funding of RIs and KBIs research programmes within a framework of competitive grants based on triangulation (KBI-RI-MHTI consortia) and aimed to increase multidisciplinary R&D; xi. Create a STEMIT Human Capital Mobility Fund for incentivising the movement of STEMIT personnel from RIs and KBIs to MHTI and *vice versa*; and, xii. Reform all under-graduate STEMIT curricula to include an industry placement component ('thin' or 'thick' sandwich of three months or six months per academic year, respectively).
Actor Importance and Government [GOV] [ISTC] Inter- Intra-Actor Linkages		
Truncated linkages at best, at worst a myopic view of systemic relationships pertinent to innovation in the national economy.	This truncated view tends to occlude government from the overall governance of the NSI in terms of: i. Coordination of government actions and funding in STI, especially between KBIs and MHTI; ii. STI organisations' stability (human capital, funding support); iii. Institutionalising evidence-based policy-making (KNSI Survey applied longitudinally as an advanced assessment, monitoring and evaluation method for managing the NSI); iv. Evaluation of the mix of policy instruments; and v. Catalysts for higher networking densities across the KNSI.	i. Ministry of Industrialization and Enterprise Development (MoIED) and the Ministry of Education, Science and Technology (MEST) should become superordinated as a Ministry of Innovation, Science, Technology and Industry (MISTI), with the Ministry of Education (ME) as a separate but very closely coordinated ministry. MISTI becomes the primary formulator and coordinator of all KNSI policy and strategy through a statutory inter-ministerial KNSI Policy Unit (KNSIPU), chaired by the two ministers (MISTI and ME) and reporting to cabinet; ii. The KNSIPU should have oversight of, and responsibility for, NSI policy, planning and funding; and integrating the operations of the three state agencies NACSTI, Kenia and NEF as well as monitoring, evaluation and assessment of KNSI Actors' performance; iii. Establish a biennial standing conference – The Innovation Forum Series – (sponsored by the Government) on 'Innovativeness and Innovation in the National Economy' involving all four Actors in the KNSI; iv. The KNSIPU should be mandated with setting priorities, defining national and regional policy orientations, and budgetary appropriations concerning innovation regarding its mandate; v. Require that government innovation policy-making formally and legally consults all KNSI Actors through a 'white' paper and 'green' paper process that involves all four Actors; and, vi. Establish a legally-binding formal consultative process (six monthly) between the KNSIPU and MHTI (and industry associations), KBIs and ARBs regarding innovation policy.

Policy Implication	Specific Implications	Policy Recommendations
Actor Importance and Medium and High-Tech Industry [BE] Inter- Intra-actor Linkages		
Business Enterprise (MHTI) isolation leaves them far removed from the policy making process, particularly articulation and calibration of policy to industry needs.	Business Enterprise are remote from: i. An influential role in setting public procurement policy; ii. Encouraging cooperation and collaboration between KNSI Actors, especially between ARBs, ISTC and industry associations; iii. Prominence in the overall governance of the KNSI (strategic disposition, orientation and policy priorities); iv. Projecting to the GoK the factor constraints to innovation that they confront; v. Reviews and adjustment of regulatory regimes (including performance requirements and standards setting) that govern the relationship between public resources and the private sector with respect to innovation; vi. Enabling the removal of obstacles and impediments to public private-sector partnerships for innovation initiatives; vii. Being fully convergent with GoK priorities with respect to demand-signals, as well as fostering human capital mobility from Business Enterprise to GOV (and from GOV to Business Enterprise) to enhance cross-sector collaboration (notwithstanding the need to moderate potential conflicts of interest); and, viii. Participating fully in the national industrialisation policy as the key driver to lead in contributing to GDP growth.	i. Condition the management of indirect and direct support to Business Enterprise and MHTI (fiscal and monetary incentives, matching funds, subsidised loans and grants, regulatory and standards setting interventions) and financial sector support (guarantees and venture capital) to Business Enterprise engagement with other KNSI Actors especially KBIs; ii. Institutionalise the role of Business Enterprise associations and councils in the policy governance of the KNSI through legal and formal consultative processes (including 'white' and 'green' papers); iii. Reconfigure ICT-based public procurement policy to require pre-qualification to tender based on MHTI inter-linkages with other Actors, especially RIs and KBIs; iv. Recalibrate industrial strategic sector support to require formal collaborative arrangements between MHTI and public sectors, and KBIs and ARBs, under terms and conditions of matching resources from MHTI companies, RIs and regional government; v. Incentivise Industry Associations and Chambers of Commerce to create liaison offices that deal in a triangulated manner with KBIs, ARBs and GOV; and, vi. Incentivise the mobility of personnel between private and public sectors by opening up the STEMIT Human Capital Mobility Fund to SMEs in MHTI.
Actor Importance and Knowledge-Based Institutions [HE][RI] Inter- Intra-actor Linkages		
Knowledge–Based Institutions, at best poorly connected, and at worst unable to tap into, and exploit, stocks and flows of knowledge.	Specifically, Knowledge-Based Institutions (HE, RI) are occluded in terms of: i. Participation in the research and development networks of KNSI Actors; ii. Managing the supply-side of advanced human capital resources, and Data, Information, Statistics and Knowledge (DISK) to MHTI in keeping with industry needs; iii. Responding effectively to the demand-side of human resource requirements from MHTI; iv. Priorities in specialisation (from other Actor perspectives); v. Inter-HE and RIs institutional competitiveness; vi. Pedagogic and curricula programme developments that serve other Actors, especially MHTI; vii. Alignment of competitive enhancement of Knowledge-Based Institutions with regional development priorities; viii. Strategic development of Knowledge-Based Institutions' own capacities and capabilities, ix. Gaining significant benefits from outreach programmes; and, x. Exploiting their IPRs for LPRs, spin-offs and raising funds.	i. Eliminate regulations and contractual obligations that prevent Knowledge-Based Institution personnel (STEMIT researchers) from participating in industry R&D; ii. Use the STEMIT Human Capital Mobility Fund to incentivise movement of Knowledge-Based Institution personnel to government policy organs, MHTI and ARBs, and *vice versa*; iii. Require Knowledge-Based Institutions to hold annual 'open' days with MHTI and ARBs involvement where the results of competitively assessed R&D from HEs and RIs, and STEMIT undergraduate, post-graduate, doctoral and post-doctoral projects/studies are displayed for the purposes of generating IPRs; patent, license and royalty fees through collaborative product development and commercialisation; iv. Require Knowledge-Based Institutions in concert to host a biennial Standing Conference on 'the role Knowledge-Based Institutions in innovation' involving MHTI, ARBs and GOV; v. Move sequentially away from block grants toward competitive funding for Knowledge-Based Institutions based on performance criteria related to their engagement with MHTI and other KNSI Actors; vi. Require Knowledge-Based Institution STEMIT departments in collaboration to conduct technology foresight exercises with MHTI, ARBs and GOV; vii. Evaluate Knowledge-Based Institution performance for R&D 'top up' grants on the basis of triangulation, STEMIT inter-departmental collaboration and academic–industry co-operation indicators; viii. Require Knowledge-Based Institutions to create, alongside IPR offices, MHTI liaison offices to intensify academic–industry networking; ix. Require Knowledge-Based Institution STEMIT curricula redesign to meet market demand to include formal consultative process involving MHTI, in order to attract government funding; x. Reform the academic human resources policy for recruitment to enable MHTI practitioners and executives to teach in STEMIT programmes, and permit sabbaticals in MHTI by STEMIT academics; xi. Require STEMIT researchers receiving government support to be embedded in MHTI for 50% of the R&D duration; and xii. Require STEMIT academic promotions to be based on productive links with MHTI.

Policy Implication	Specific Implications	Policy Recommendations
Actor Importance and Arbitrageur [ARB][FI] Inter- Intra-Actor Linkages		
Arbitrageurs are severely limited in their role in intermediation.	Specifically, Arbitrageurs are: i. Isolated from ISTC and KBI (HE, RIs) – the primary sources of DISK – and are therefore severely limited in their intermediation; ii. Debilitated in their role of linking RIs, HE and ISTC to BEs *via* private equity financing; iii. Occluded from increasing the technological capacity of BEs through knowledge brokering; iv. Unable to influence significantly strongly the GoK policies that configure the role of Arbitrageurs in the innovation landscape of Kenya with respect to IPR within the national industrialisation policy; and, v. Limited in their support in realising the goals of Vision 2030 in terms of intermediating national, as well as international, sources of knowledge within an effective and efficient NSI.	i. Condition indirect and direct support to the capital and financial industry on Arbitrageur engagement with MHTI, KBIs and ISTC; ii. Use direct support measures (subsidised loans and grants) to match venture capital, private equity investments in KBI 'spin-offs' and incubator projects; iii. Recalibrate the tax code to permit private equity and venture-capital investments in KBI and MHTI R&D activities to be written off against profits; iv. Require participation of capital and financial industry associations in the formal consultative processes related to KNSI and innovation policy; and, v. Incentivise the intermediation role of Arbitrageurs by reducing the conditions for establishing investment funds.
Importance of KNSI Actor and Strength of Actor-Centric Linkages		
Nexus of industrial innovation and innovation policy largely absent from the KNSI.	i. There is insufficient information exchange between MHTI, GOV and KBIs; ii. ARBs are isolated from the DISK functions of the KNSI and play no significant active role in terms of intermediating knowledge transfers through modalities such as the financial, or venture capital, frame-working of IPRs, and licensing regarding the IPRs either emanating from KBI, or between KBI and MHTI; and iii. The ARB intra-linkages have very few (if any) significant externalities. The policy implications of this asymmetry in Actor inter-linkages concern the absence of: i. Reciprocating relations of communications, coordination and exchange functions formalised through, for example, well-functioning standing committees and conferences; and, ii. Operative high-performance councils on Science, Engineering Technology and Innovation, economic and social research, and the 'knowledge brokering' role of ARBs (FI). Furthermore: i. ARBs do not have open access to DISK created by, and held within, KBI. ii. ARBs are prevented from adding value to the DISK by acting as conduits (framed by financial operations) to MHTI or investing directly in KBI hosted incubators or spin-offs; iii. The [BE]ARB-BE linkage has less depth to it than otherwise in the absence of proactive ARB access to DISK from KBI; iv. The [GOV]ARB-GOV linkage is likely to be devoid of the practicability of ARBs being able to persuade convincingly GOV towards policies that enhance the stocks and flows of knowledge in, and through, the KNSI; v. KBIs are not engaging sufficiently with MHTI with respect to communication of R&D; and vi. MHTI is disabled from influencing GoK policies regarding STI. The policy implications of public goods provision by GOV are: i. Very low returns from the expenditure in treasury, organisational effort and transaction costs ; and, ii. The externalities – the fundamental reason for providing the public goods – are seriously limited thus reducing considerably the effectiveness and efficiency of the KNSI.	The policy recommendations to address these gaps, asymmetries, defects and deficiencies are: i. Initiate of a formal consultative process on innovativeness and innovation in the national economy involving GOV, MHTI, KBIs, and ARB using, Standing Conferences as well as 'white' and 'green' paper protocols; ii. Ensure recruitment and accountability standards, managerial requirements and governance structures are harmonised, and linked to performance requirements, across KBIs (RI, HE); iii. Eliminate constraints preventing public-sector institutions from engaging in STEMIT activities with the private sector; iv. Adopt common performance agreements (linked to funding), that have external triangular relationship indicators, across KBIs (RI, HE); v. Increase economies of scale and scope by dissolving poor performance RI, merging middling-performance RI and selectively corporatising high-performance RI; vi. Create a Science, Engineering, Technology, and Innovation Research Council (SETIRC) chaired at vice-presidential level to signal seniority to re-strategise the mandates, purpose and functioning of national agencies and research institutes with respect to innovation policy and innovativeness in the national economy; vii. Adopt an 'open to all' KBI Information Reporting System on STEMIT which is centralised and posts information on research (grants, topics and achievements), curricular developments, graduates (output, enrolment and employment rates per discipline), full-time faculty rates, and scholarships; viii. Adopt advanced monitoring and evaluation practices for evidence-based assessment of KBIs and policy instruments to address the disconnects between KBI, MHTI and ARB on the one hand, and incentives and performance on the other hand; ix. Accelerate the strategy for e-Government; x. Perform an audit of the policy mix of instruments and incentives aimed at increasing innovativeness; xi. Reconfigure public sector procurement policy, terms and conditions to require triangulation between MHTI, KBI and ARB;

Policy Implication	Specific Implications	Policy Recommendations
	i. The GOV framework of incentives for KBIs (fiscal, monetary, regulatory, standards and performance requirements) is likely to be ineffective in that GOV either tends not to demand KBI-MHTI engagement, or does not enforce such engagement in return for providing financial support to KBIs (and students) in STEMIT; ii. GOV support to KBI is largely ineffective in the absence of other linkages; iii. The performance required from KBIs by GOV is limited at best, and at worst has no dimensions that encourage KBIs to engage proactively with other KNSI Actors through modalities such as rankings of STEMIT departments and faculties, conditioning financial support (concessionary loans, research grants, etc.) on output performance (journal publications, trademarks and patents filed and awarded, license fees and royalties received and paid, IPRs commercialised through incubators and 'spin offs' or through MHTI, and establishing IPRs offices in KBI to engage with MHTI, etc.); iv. Need for across the board recalibration of STEMIT under- and post-graduate courses to the needs of MHTI by integrating intra-mural course work with extra-mural (MHTI Embedded) industrial work experience facilitated by GOV supported biennial exhibition of KBI IPRs to MHTI; v. Reconfiguring the national service programme relevantly toward internships in MHTI for STEMIT students; vi. Conditioning financial support (research and 'top up' grants, etc.) on joint research with MHTI; vii. Redesigning final year undergraduate and postgraduate projects in STEMIT to be inter-disciplinary involving a minimum of three, and maximum of six, students to address a specific local problem in the vicinity (e.g. building water sanitation, drainage, waste recycling, or building a localised electricity network using solar technology etc.) in order to seed, and initiate, the potential for graduates to create their own employment; viii. The absent and VI-VW inter-linkages (GOV-ARB, HE-FI, RI-ARB, BE-GOV, ARB-ISTC) between intermediating actors and other actors in the KNSI means that the KNSI is at best limited in its communicative, cooperative and coordination functions and at worst unable to cohere the transmission of DISK throughout the system; and ix. The missing MHTI-GOV, MHTI-KBI inter-linkages severely limit the absolute levels of innovativeness and throttle the rate of innovation in the economy. The policy implications of VI-VW inter-linkage between BE-ISTC include: i. Truncated relations with markets, and shortfalls in MHTI in the commercialisation of KBI's IPRs, especially in the light of the absence of significant MHTI-KBI, MHTI(BE)-GOV(ISTC), MHTI(BE)-KBI(RI) inter-linkages; ii. The absent KBI ([HE]BE-HE) inter-linkages exacerbate the inability of ARB to proactively intermediate; iii. From a stocks and flows perspective, the stocks of KBI IPRs find little or no receptive outlets in MHTI, and hence there is little or no flow of intellectual property and knowledge within the KNSI; and, iv. GOV performance requirements from MHTI, RI and ISTC are very limited. General policy implications are that there are: i. Conspicuous gaps in MHTI-KBI, MHTI-ARB, MHTI-GOV and ARB-KBI (and *vice versa*) linkages; ii. Noting that MHTI, KBI and ARB Respondents have few (compared to GOV) significant assessment of inter-linkages among other Actors in the KNSI, it would appear that the policy levers available to GOV are, at best, configured insufficiently well with respect to the other actors, and at worst remote for effective policy direction and efficient policy craft;	xii. Use regional development funds to triangulate regional government, industry associations and KBIs for developing clusters; xiii. Ensure MHTI, KBIs and ARB representation on the SETIRC (Chambers of Commerce and University Councils); xiv. Adapt the Foreign Direct Investment (FDI) regulatory regime to adjust its modal neutrality to favour business collaboration and R&D joint ventures between foreign investors, MHTI and KBIs; and, xv. Adapt the tax code to favour venture capital investments in the KBI IPRs.

Policy Implication	Specific Implications	Policy Recommendations
	iii. Limited ability on the part of GOV to enforce policy (and hence behaviour regarding innovativeness) with respect to KBI-MHTI, ARB-KBI and ARB-MHTI inter-linkages, and specifically to MHTI regarding the targeting of early adopters and early majority in the diffusion of innovation. The policy implications of the asymmetrical assessment of the correlation Actor importance and Actor inter-linkages, biased to GOV-KBI, KBI-GOV include: i. A KNSI that is seriously deficient along the axes KBI-MHTI (*vice versa*), GOV-MHTI (*vice versa*), ARB-KBI (*vice versa*), MHTI-ARB (*vice versa*); ii. This deficiency is compounded by the isolation of GOV, MHTI, KBI and relative isolation of ARB, absence of MHTI-ARB, MHTI-KBI and ARB-KBI, inter-linkages; iii. The inter-Actor dialogue on innovation and innovation policy is therefore far from complete with respect to KBI-MHTI (*vice versa*) MHTI-GOV, ARB-GOV, MHTI-ARB (*vice versa*) and ARB-KBI (*vice versa*) inter-linkages; iv. The lateral sides of the Triple Helix type 4 (KBI-MHTI and GOV-MHTI) on which industrial innovation *via* IPRs and innovation policy should be manifest is missing; and, v. The side on which financial intermediation pumps creative ideas and DISK to, and facilitates IP commercialisation in, markets is also largely missing.	
Government [GOV][ISTC] Inter- Intra-Linkages – Level of Innovativeness of Business Enterprises		
Lack of policy mapping of KNSI for policy monitoring and evaluation.	i. The Government not having readily at hand the full means and instruments to map and measure the KNSI for policy assessment, monitoring, evaluation and adjustment despite extant policy documents on STI, and in spite of GoK perceptions on other Actors' linkages; ii. The extent to which government is, itself, isolated from the KNSI regarding government inter-linkages which are deemed very strong only with HE (a traditional link) and non-existent with all other Actors as assessed by ALL Respondents presents a serious challenge to government efforts in creating a higher performance NSI even if significant funding becomes available in the near future; iii. Government not having means at hand to map and measure the level of innovativeness systemically in the national economy; iv. The Government's ability to manage the conflictual/co-operative balance between Actors, institutions and organisations regarding competition for resources in favour of co-operation is at best tentative, and at worst doubtful; v. Innovation policy coordination is also subject to higher levels of uncertainty than would be otherwise with the availability of comprehensive 'road maps' of the KNSI; vi. Achieving convergence in innovativeness with competitor countries is likely to be extremely difficult; vii. The Government's ability to orchestrate the strategic coherence of the KNSI is vague; and, viii. The Government tends to perceive its role as limited to a distributor of resources. The key policy implications group into: i. Lack of well-calibrated instrumentation to monitor the level and rate of innovativeness; ii. Under-leveraged legislative power; iii. Muted policy dialogue; and, iv. Competitive divergence below that of potential frontier EMEs. Specific implications are: i. The Government command over the environment for innovation is insufficiently accomplished to foster rapidly, through policy incentives, regulation and performance requirements, economy-wide levels of innovativeness by other KNSI Actors;	The policy recommendations to address these long-term threats to the KNSI are: i. the SETIRC along with the KNSIPU to strategise and prioritise a KBI-MHTI centred innovation system by legislatively allocating 2% of GDP for public expenditure support to the science and technology sector , which can leverage private sector efforts; ii. ensure that the public sector science and technology base (represented by RIs) is not divorced from MHTI R&D by requiring KBIs (RIs) to instigate formal and regular fora of dialogue on R&D agendas with MHTI, and Industry Associations and involving Government ; iii. adoption of the methodology for surveying NSI for longitudinal monitoring, assessment and evaluation of the KNSI regarding policy implementation, as well as measuring the 'fitness' of KNSI Actors with a view to applying incentives to improve fitness; and, iv. the KNSIPU to streamline the regulatory environment for STEMIT by auditing regulations to identify and remove burdensome legislation, and to propose new regulations that accelerate innovativeness and innovation in the economy.

Policy Implication	Specific Implications	Policy Recommendations
	ii. The Government may be under-leveraging its legislative power with respect to increasing the level of higher-resolution standards in the provision of goods and services; iii. The policy environment may be insufficiently configured by the Government to encourage higher levels of innovativeness systemically; iv. The role of government, as the prime driver of the economy, is not fully utilised in encouraging innovativeness and innovation among early adopters and early majority in the diffusion of innovation paradigm, through government procurement requirements, legislation and regulation; v. The very weak government linkages at best mutes, and at worst disables, the policy dialogue between KNSI Actors; and, vi. GOV-BE (and *vice versa*) links are neither resulting in high innovation, nor is government contributing significantly to the innovativeness of BEs	
Business Enterprises [MHTI] Inter- Intra-Linkages - Level of Innovativeness of Business Enterprises		
Innovation is primarily manifest in industry (supply-side) and markets (demand-side), however BE isolation means little access to other sources of knowledge.	i. Given Business Enterprise almost total isolation from other Actors in the KNSI, especially from Government and KBIs, MHTI has little, if any, access to sources of innovation other than its own research and development expenditure and efforts; ii. Reciprocating relations with KBIs are also limited and therefore the exposure of Business Enterprises to DISK is severely reduced; iii. The VW-VLI deficiency should be viewed through the lens of government's limited and uneven command over the environment for innovativeness and innovation, which in turn implies that the performance and regulatory dynamic for increasing standards and competition is lethargic; iv. Opportunities to leverage and synergise Business Enterprise R&D with that in RIs are severely limited, despite extant government incentives to Business Enterprises and grants to KBIs and RIs; v. The identification of 'promising local companies' and potential 'national champions' is obscured; vi. Market signals with respect to demand are likely to be largely unnoticed; vii. Opportunities for generating externalities through cross-cutting licensing and patenting, and concomitant fees are limited; and, viii. The role of ISTC is stymied.	i. Consider preferential tax rate for MHTI as a function of triangular (MHTI-KBIs-ARB) R&D, joint product development, sub-contracting relations; ii. Address the barriers to innovation specifically identified by MHTI; iii. Initiate under the SETIRC a programme of identifying SMEs that are 'promising local companies' in MHTI and assisting them to grow; iv. Initiate under the SETIRC a 'commercialisation and marketing framework' in tandem with the promising local companies programme that incubates spin-offs and SMEs in MHTI from the triangulation mentioned above; v. Configure, as part of the Government venture capital system, a Technology Commercialisation Fund (TCF) access, to which requires triangulation (MHTI-KBI-ARBs) to enable R&D to become IPRs that can be licensed; and, vi. Perform an analysis of FDI spillovers to MHTI and adjust the FDI regime to enhance spillovers and externalities.
Higher Education [KBI] Inter- Intra-Linkages - Level of Innovativeness of Business Enterprises		
KBIs have highly restricted outlets through intermediation and commercialisation, to demand markets; poor market intelligence; and are insufficiently aware of market needs.	i. The very weak Higher Education inter-linkages with ARB, FI, ISTC, BE, suggest that KBI DISK and IPRs do not have outlets, through intermediation and commercialisation, to demand markets; ii. KBI (Higher Education) have relatively poor market intelligence capacity and capability – in other words they do not know with sufficient accuracy what MHTI (BEs) and the market need and, as such, can neither respond to, nor address, those needs through appropriate innovative solutions regarding curricula reformation on R&D; iii. The management of the KBI IPRs system, such as it is, is likely to be remote from users [MHTI (BEs)] and inter-mediators [ARB (FI)]; iv. STEMIT curricula redesign with mandatory industrial placements is likely to be hampered; v. Research is likely to be tangential to the needs of MHTI; vi. Opportunities for industry funded and sponsored R&D, as well as product development, leading to incubation and spin-offs (in high technology) into SMEs are truncated; vii. IPR based opportunities for fund raising are limited; viii. The divergence of assessment of HE linkages and level of innovativeness between GOV, ALL and KBI respondents (GOV is optimistic, ALL and KBIs are pessimistic) implies a reluctance on the part of the GoK to address deficiencies; ix. Regarding the HE-ISTC linkage while 65.3% of GOV respondents assess this as VS-VHI only 9.1% of KBI indicate this, therefore reinforcing the optimistic view of GoK and its tendency not to address concerns urgently; and x. The convergence of assessment of HE-ARB as VW-VLI by ALL (59.8%), KBIs (68.7%) and RI-ARB as VW-VLI by 52.4% of KBIs indicates the inability of KBI to use ARB as conduits to the market.	i. Adopt a competitively incentivised IPR management system for KBIs that disproportionately rewards KBIs with the highest STEMIT IPR performance (LPRs and industrial contracts); ii. Reconfigure funding of post-graduate studies to favour disproportionally STEMIT programmes; iii. Provide incentives (fiscal, monetary, regulatory and performance requirements) for STEMIT post-graduates to work in the private sector; iv. Redesign STEMIT post-graduates courses and programmes to require mandatory one-year placements in an MHTI (particularly SMEs) firm, where part of the research is performed; v. Reconfiguration of the public service entrance and promotion examinations system to link to STEMIT, management courses and programmes in KBIs; vi. Incentivise MHTI to write off against profits industry funded and sponsored R&D that takes place under contract in KBIs; vii. Reconfigure the mandates, and performance assessment criteria, of ISTC from reactive to proactive engagement with KBIs; and viii. Recalibrate the fiscal conditions pertaining to ARBs to enable write off against profits, ARB funded equity positions in KBI spin-offs, R&D and commercialisation of KBI IPRs.

Policy Implication	Specific Implications	Policy Recommendations
Research Institutes [KBI] Inter- Intra-Linkages - Level of Innovativeness of Business Enterprises		
Strategic research and development operations misaligned with the needs of MHTI specifically and that of the market in general.	i. The policy analysis points to at best a distracted and solitary role, and at worst a dysfunctional role, of Research Institutes in the KNSI; ii. Research Institutes (strategic and applied) research and development may be divergent to the needs of MHTI; iii. Even if Research Institutes DISK transmission mechanisms have potential, the complete isolation of ARB from RIs, ISTC and HE in the KNSI implies truncation as the financial support framework for commercialisation of R&D and DISK is missing to a large extent; iv. An absence of a sales and marketing disposition on the part of Research Institutes with respect to IPRs, BEs and MHTI; v. Opportunities for funding, sponsorship and R&D joint ventures with MHTI (intermediated by ARB) are severely limited; vi. Opportunities for human capital mobility between Research Institutes and MHTI are truncated; vii. The research agendas of Research Institutes is likely to be divergent from the demands of the market place; and, viii. The divergent assessment between GOV and KBI would tend to moderate the urgency with which GoK addresses challenges.	i. In addition to the national auditing of Research Institutes, submitting Research Institutes to external international review by bodies such as UNIDO, OECD, and South Africa's National Advisory Council on Innovation (NACI); ii. Recalibrate Research Institute human resources policy, terms and conditions to enable Research Institute staff to perform their research in MHTI companies in terms of sabbaticals, contracts or under patents, licenses and royalty protocols; iii. Reconfigure government procurement of services from Research Institutes to require triangulation by Research Institutes (i.e. RI-MHTI-ARB) in the provision of services; and, iv. Reconfigure government funding support to Research Institutes to be contingent on matching funds to that raised by Research Institutes from MHTI in the form of sponsorships, LPRs, research funds.
Arbitrageurs Intra- Inter-Linkages - Level of Innovativeness of Business Enterprises		
Stocks of knowledge are unexposed and flows of DISK are glacial at best and non-existent at worst.	i. Truncated efforts by Arbitrageurs to intermediate DISK from KBI to MHTI and BE, and therefore stocks of knowledge remain unexposed while any flows are, at best, glacial; ii. The non-existent GOV-ARB and very weak ARB-GOV inter-linkages indicate limited ability of Arbitrageurs to influence innovation policy with respect to intermediating between KBI and MHTI; iii. Arbitrageurs are, by and large, unable to exploit the competitive advantages that arise from information asymmetries extant between KBIs and other KNSI Actors to generate positive externalities; iv. Arbitrageurs are largely cut off from taking equity positions in either potential start-up businesses, based either on KBI R&D outputs or spin-offs from KBI and MHTI; v. The crucial role of ARB linking the GOV-KBI-MHTI axes of the Triple Helix type 4 is largely missing; vi. The view of GOV that ARB linkages are VS-VHI suggests that GoK is likely to be reluctant to address issues pertaining to very low levels of innovativeness in an urgent manner; and, vii. The absence of significant assessment by GOV Respondents on ARB inter-linkages points to a myopic view by GoK of the intermediating roles of ARBs. viii. There is a void in the triangulation MHTI-ARB-KBI; ix. Triangulation between MHTI-ARB-GOV is vacuous; x. Consequential voids in the triangulations between BE-FI-RI/HE and BE-FI-ISTC; and xi. Disconnects between ISTC, BEs, FI, and RI/HE (the source of DISK) point to dysfunctionalities in the mandates and roles of institutions supporting technical change in the economy.	i. Decide a strategy for expanding the size, and deepening the 'thickness' of the capital and financial markets in Kenya in terms of number of firms, as well as the availability of Venture Capital ; ii. Condition fiscal and monetary, as well as standards, regulatory and performance incentives to the finance capital industry on the intermediation role of Arbitrageurs, with respect to KBIs and MHTI; iii. Use Government-Backed Venture Capital to match equity positions by Arbitrageurs in technology incubation programmes in KBIs; iv. Require future KBI development of science and technology parks to have 'anchor' tenants from finance capital industry; v. Use the STEMIT Human Capital Mobility Fund to support mobility of personnel in finance capital to teach in KBIs (sabbaticals) with respect to Venture Capital management of R&D, and commercialisation; vi. Map the structure of early stage financing of innovation and entrepreneurship in Kenya; vii. Restructure Government-Backed Venture Capital into separate funds relevant to stages of innovation and entrepreneurship to induce the finance capital industry to enhance their intermediation; viii. Increase competition in the finance capital industry by adjusting fiscal conditions to enable high net-worth individuals to invest directly in start-ups or in venture capital funds; ix. Instigate a formal consultative process between GOV, ARBs, KBI, MHTI with respect to reducing barriers to ARB intermediation; and, x. Consideration to enabling the capital and financial markets in Kenya to launch secondary (less regulated) markets. The policy recommendations to address the imperfections of truncated and absence of high level of innovativeness in BEs involve: i. Reconfiguring and recalibrating the mandates and roles of institutions supporting technical change so that they are incentivised to take a proactive stance with respect to engaging with FIs and venture capital on the one hand, and on the other hand, gearing with BE regarding DISK from RI/HE;

Policy Implication	Specific Implications	Policy Recommendations
		ii. Ensuring that incentives applicable to FIs and venture capital be audited for 'fit-for-purpose' with respect to encouraging them to intermediate more effectively and efficiently between RI/HE and BEs (and *vice versa*); iii. Ensuring that ARBs are increasingly central to triangulation with BEs and RI/HE through stipulations that fiscal incentives in terms of gains to FIs and venture capital to RI/HE regarding incubation and spin-offs; iv. Using GOV control over development finance institutions to drive monetary support to BEs to require BEs engaging with RI/HE as well as venture capital in investing in incubation and spin-off enterprises housed in KBIs; and v. Employing standards setting and performance requirements to encourage ARBs to meet performance indications that reflect innovativeness
Latent Factors to Barriers to Innovation - ALL		
Barriers to innovation to be tackled economy-wide as well as in terms of Actor-specific interventions.	Overall, the key policy implication is that without an appetite for risk taking, supported by a policy environment that influences the behaviour of markets, and threshold levels in skills-ICT capability/capacity, economy-wide innovativeness and innovation is extremely difficult. Specific policy implications include: i. In resource constrained circumstances, the crucial choice is where fiscal and monetary incentives, as well as standards, regulation and performance requirements, should be directed to improve the most significant Factor 1 <Uncertainty Avoidance & Risk>, through stemming the 'Brain Drain' and reducing the 'Organisational Rigidities'; ii. In terms of policy implications (and hence the sequencing of policy implementation through Actor specific business plans and managerial action) the four factors have different temporal characteristics in terms of policy action (but not necessarily policy outcome); iii. F1 <Uncertainty Avoidance & Risk> is relatively long term (5-10 years), given the organisational dynamics and need to change institutional behaviour, although short-term action can be taken immediately to stem the 'Brain Drain' by changing the terms and conditions pertinent to knowledge workers and the highly qualified as well as altering the structure of certifying qualifications to incentivise incumbency (without compromising performance); iv. F2 <Unsophisticated Markets> is medium-term (3-5 years) given the legislative aspect of putting into place higher resolution regulations (and standards); v. F3 <Skills Capacity> is relatively short-term (1-3 years) at least in terms of curricula redesign at tertiary level ; vi. F4 <ICT Incapacity/Incapability> is relatively short term (1-3 years) given the infrastructure aspect of laying down ICT Capacity; and, vii. All factors are important and have to be addressed by government policy on innovation.	An overview of the factor barriers to innovation assessed by ALL Respondents as well as the different Actors in the KNSI discloses four major recurrent policy dimensions, there are <<Excessive Risk>>, <<Maladjusted Markets>>, <<Exiguous Human Capital>> and <<Exiguous Human Capital>>. The policy recommendations to address <<Excessive Risk>> within the KNSI are: i. Reconfiguring the procedural system in terms of eliminating bottlenecks in permits for doing business; ii. Revamping the Government Backed Venture Capital and development finance to facilitate access to credit for innovative entrepreneurship and R&D demonstration and pre-commercialisation stages; iii. Recalibrating the fiscal regime to favour innovative entrepreneurship; iv. Initiating programmatic co-ordination of support to innovation in MHTI and KBIs conditional on triangulation (MHTI-KBIs-ARBs); and, v. Initiating a triangulation programme to enhance the absorptive capacity and adaptive capability, regarding imported and local technologies, in micro-small-and medium-sized enterprises (MSMEs) in MHTI. The policy recommendations to address <<Maladjusted Markets>> within the KNSI are: i. Using the regulatory framework for adjusting (spatially and temporarily) the standards and performance requirements that regulate markets such that MHTI firms are coerced towards higher levels and rates of technological adaptation *via* environmental standards, economic performance measures as well as directives on innovation in specific strategic sectors; ii. Use of standards setting for increasing the rates of substitutions of capital or labour in order to dynamise markets; iii. Reconfiguring government and public monopolistic procurement terms and conditions to encourage innovation (e-filling, triangulation, R&D component of contract bidding, etc.,); iv. With the perspective of technology/product 'push, strengthen the incentives framework for the commercialisation of R&D in KBIs; and, v. Initiation of a trade-mark and management patent corporation to coordinate the commercialisation of IPRs from publicly funded R&D.
	Latent Factors to Barriers to Innovation - Government	
	The key policy implications from GOV identified barriers to innovation reflect those specific to ALL Respondents. Specific implications are: i. In resource constrained circumstances, given the trade-offs, funds and policies should be directed to lowering risks and restrictions in the long-term on the one hand, and on the other hand increasing explicit sector support to STEMIT and MHTI in the short-term. In the long-term, resources should be directed to increasing the culture of innovation and rewarding entrepreneurial risk taking;	The policy recommendations to address <<Exiguous Human Capital>> within the KNSI are: i. Recalibrating curricula, especially at the tertiary level (with feed through to the secondary level), to the needs of MHTI; ii. Reconfiguring the quality and quantity of secondary and tertiary, as well as vocational and enterprise-based training towards STEMIT and management to permit skills upgrading commensurate with capital substitution for labour; iii. Increasing the autonomy (fiscal and management) of KBIs conditioned on performance requirements that favour conjoint training programmes with MHTI (such as STEMIT programmes embedded in business enterprises) and triangulation; and,

Policy Implication	Specific Implications	Policy Recommendations
	ii. Increasing the resolution of standards, predictably over the medium-term, by means of the regulatory system of law making and conditionalities of government procurement to encourage the sophistication of demand and supply markets; iii. For factor markets to meet higher resolution standards overtime they are forced to be more adaptive of new technology, to become more innovative and hence more productive; and iv. Without adequate human capital resources, especially in STEMIT, economy wide innovation and innovativeness is virtually impossible to achieve. The pivotal role of STEMIT in industrialisation productivity gains and sustainable economic modernisation (from factor driven to innovation driven development) is widely acknowledged as the *sine qua non* of socio-economic advance through structural change.	iv. Given the spatiality of the KNSI, upgrading continuously the ICT infrastructure to enable (A) Link-up of the locations contributing most to GDP on a priority basis, (B) Lower ICT costs, and (C) Link-up of all KBIs, RIs and Government STEMIT related agencies in creating a high-band-width, high speed national DISK, education and research network; and, v. Mitigating the 'brain drain' by instigating a series of GoK sponsored national human capital conferences to encapsulate Kenyan's overseas in national development. The policy recommendations to address <<Regulatory Deficiencies>> within the KNSI are: i. Reconfiguring the legislative framework for business entrepreneurship in order to reduce rapidly the process, time, and costs associated with commercialisation and start-ups; ii. Enabling the collateral of property assets to be used more intensely; iii. Encouraging investment in MSMEs in MHTI through fiscal reform; iv. Ensuring the protection of investors through the courts and accelerating the processes of insolvency to enable more rapid exit (and hence entry) in business sectors; v. Reducing barriers to trans-border trade and investment; and, vi. Aligning incentives regulation to encourage innovation.
	Latent Factors to Barriers to Innovation – Medium-High Tech Industry	
	Overall, the key policy implication is that MHTI cannot price risk adequately and hence are severely constrained in opportunities for investing in innovativeness and innovation, especially in the presence of unsophisticated markets that do not demand innovative products and services, as well as regulatory deficiencies that fail to adjust dynamically, over time and space, the standards that govern supply and demand factors. Secondary implications are: i. Government and Industry needing to engage in a standing dialogue to align priorities through targeted policy; ii. Compliant with WTO obligations, MHTI should be enabled to take advantage of explicit policy support to reduce 'Innovation Cost (Too High)' by Government assisting in financing and defraying the costs of research and development through monetary and fiscal policy; and iii. The 'central nervous system' of the economy – the 'ICT (Network) Capacity' and 'Rate of Access to ICT' – needs to be seriously upgraded in order to enable enhanced information flow, logistics, distribution and transport connectivity, and accelerate the flows of goods, services and DISK;	
	Latent Factors to Barriers to Innovation – Knowledge-Based Institutions	
	Overall, the key policy implication is that KBIs without a functional and high-performance 'central nervous system' of the economy in the form of high ICT capacity and capability, as well as adequate threshold levels of human capital, the level of innovativeness and rate of innovation in the economy is likely to be debilitating and inadequate to close the gap with the median middle-income countries. Secondary implications are: i. KBI inter-linkages with other Actors, are either missing for HE, with respect to RIs, ARB, FI, ISTC and BEs, or very weak and non-existent for RI. ii. Even if KBIs wish to commercialise DISK, due to their very weak or non-existent linkages, they find no reception in the market because of the 'ICT Capacity/ Capability' barrier;	

Policy Implication	Specific Implications	Policy Recommendations
	iii. KBIs are far distant from fully reorienting what should be their entrepreneurial role toward corporate entrepreneurship in which, incentivised by governmental fiscal, monetary, regulation standards and performance requirements, they become more business minded to exploit and commercialise DISK; and, iv. Despite the Government's relationship with KBI, with respect to innovativeness and innovation performance requirements, barriers tend to preclude sufficient adaptive behaviour by KBIs.	
	Latent Factors to Barriers to Innovation – Arbitrageurs	
	Overall, the key policy implication is that: i. There are insufficient options for taking equity positions in incubation, spin-offs and start-ups in terms of either ideation and invention or raising investment funds. This is especially serious for FIs and VC; Secondary implications are: i. The loss of inventiveness through the 'Brain Drain' presents the greatest of barriers to their intermediation role; ii. Without a critical mass of risk-welcoming talent (usually the well-educated) opportunities for intermediation are severely restricted; iii. Resource allocation decisions are likely to be less than effective and efficient than otherwise; iv. The inability to price adequately risk; v. The business environment is not supportive of, and continues to constrain, intermediation especially given the absent linkages between BEs-ARBs-RIs/HE; and, vi. The rate of ideation, invention, commercialisation is probably well below the level that the VC industry in Kenya would wish for.	
Success of Policy Instruments and Barriers to Innovation		
Poorly configured and inadequately calibrated policy instruments and interventions with respect to barriers to innovation.	i. GOV Respondents are diametrically opposed to other KNSI Actors (KBIs, ARBs) in their assessment of policy instrument success in overcoming barriers to innovation as VHS-VLC. This implicates that there is a danger that GoK may persist with policies which may be actually unsatisfactory in terms of the coherence of the KNSI; ii. Apart from policy instrument Research Grants and barrier to innovation 'Rate of Access to ICT' as VHS-VLC All Respondents deem policy instruments in relation to variables of barriers to innovation as US-VHC; iii. Crucial variables that are barriers to innovation, influenced highly significantly by latent factors (to barriers to innovation) which do not appear as VHC implies that, ALL Respondents in assessing policy instruments in relation to variables of barriers to innovation as overwhelmingly US-VHC may be occluded from a view of the efficacy of policy instruments with respect to these crucial variables; iv. The absence of significant assessment by MHTI Respondents of policy instrument success regarding barriers to innovation, and paucity of assessment by KBIs and ARB Respondents points to their collective lack of knowledge on GoK policies and their effects;	Five areas of policy recommendations are: 1) An innovation driven economy, the policy recommendations include: i. Following the evidence of policy measurement, from mapping and measuring the KNSI develop a customised innovation policy with qualitative and quantitative targets; ii. Use peer (middle-income country) innovation metrics to track and measure policy progress and effectiveness driven by the application of KNSI longitudinal surveys; iii. Embedding a culture of innovation across the management of the economy; iv. Orienting policy to address the key challenges of innovation facing the national economy ; and, v. Creating a departmental unit in the Ministry of Education (Department of KBI Skills and Innovation vi. (KBISI)) that, along with the SETIRC and the KNSIPU, ensures innovativeness across KNSI Actor behaviour. 2) Public procurement and innovation, the policy recommendations include: i. Deploying the weight of Government spending power, public procurement and public services demand, to reconfigure the environment for innovation and innovativeness; ii. Requiring all Government departments to develop an innovation oriented procurement plan for stimulating innovativeness through public spending;

Policy Implication	Specific Implications	Policy Recommendations
	v. There appears a fundamental contradiction on the part of GOV Respondents in that on the one hand they assess the variables under the dimension <<Maladjusted Markets>> as significantly high barriers to innovation, and on the other hand deem that their policy instruments in relation to these very same variables encapsulated <<Maladjusted Markets>> as VHS-VLC. The GoK appears to have, at best, an unclear appreciation of the efficacity of policy instruments in relation to barriers to innovation and, at worst, is deluding itself; vi. The primary policy instruments – Government-Backed Venture Capital, Regulation, Government Procurement, and Labour Mobility Laws (Laws and Incentives) – (once reconfigured and recalibrated) are strategically crucial to addressing and overcoming systemic deficiencies in the <<Exiguous Human Capital>> and <<Maladjusted Markets>> of the KNSI; vii. The primary policy instruments – Subsidised Loans, and Standard Setting – (once reconfigured and recalibrated) are operationally crucial to addressing and overcoming the system-wide <<Excessive Risk>> and <<Regulatory Deficiencies>> within the KNSI; viii. Three first tier major specific barriers to innovation variables, namely; 'Lack of Finance', 'Lack of Explicit Policy Support', 'Quality of Technically Trained Manpower' need to become targets of policy; ix. Two second tier specific barriers to innovation, namely 'Organisational Rigidities' and 'Innovation Costs (Too High)' need to become targets of policy attention; x. Two third tier specific barriers to innovation namely; 'Brain Drain, 'Rate of Access to ICT' and need to become targets of policy ; and, xi. Judicious policy prioritisation and sequencing suggests the policy timeframe and target with respect to policy instrument recalibration and reconfiguration to overcome barriers to innovation.	iii. KNSIPU and Department of KBISI to facilitate mobility of private sector personnel into the public sector with respect to innovative procurement practices; iv. Using Government procurement (central, regional, local) to create 'lead markets' for innovative products and services; v. Government to have a posture of an 'innovator' and 'early adopter' in the diffusion of innovation paradigm; vi. Consolidate the array of public procurement Authorities, Agencies, Boards into a centralised Government Procurement Service with a mandate to procure on the basis of innovative solutions; and, vii. Opening up procurement windows for SMEs in MHTI. 3) With respect to IPRs, spin offs and business incubation, the policy recommendations include: i. Government, as a monopolistic purchaser of products and services, along with KBIs, to focus on supply-side regarding innovative SMEs in MHTI; ii. KBIs to be required to create business incubators (for spin offs) into which is fed the results of STEMIT research at masters, doctoral and post-doctoral level; iii. Differentiate Government support to entrepreneurship much more finely in terms of fiscal/monetary, managerial and technological levels; and, iv. Leverage Government-Backed Venture Capital through triangulation with private sector and Arbitrageur funding of incubators. 4) STEMIT as the prime drivers of innovation, the policy recommendations include: i. Stipulating a government target of 3% of GDP to support R&D in STEMIT, then doubling to 6% of GDP within ten years; ii. Leveraging private R&D expenditure in support of STEMIT through fiscal recalibration, matching funds and direct support; iii. Requiring all public expenditure on STEMIT programmes to generate patent, licensing and royalty fees as part of Government equity position in support of STEMIT; iv. Initiating a specific KBI Innovation Fund to support STEMIT spin-offs from KBI research; v. Requiring KBIs to perform entrepreneurially (in an integrated manner) as a KNSI Actor the roles of: undertaking STEMIT research, pedagogy, knowledge transfer (to/from industry), act as national and regional conduits into the global knowledge economy, and lead in the design and delivery of regional economic development strategies, against performance-based targets; vi. Reorienting education toward life-long learning, particularly in STEMIT and for innovation; and, vii. Adopt a geo-spatial information systems (GSIS) approach to policy-making. 5) Absorbing international knowledge innovation and technology, the policy recommendations include: i. Focusing on connecting the urban centres in the super region formed by the parabolic Western - Central Rift Valley – Central – Nairobi – Lower Eastern – Southern Coast; ii. Requiring KBIs to develop international strategic partnerships , as part of conditions for public support, aimed at knowledge, technology and IPR/LPR transfers; iii. Measuring KBIs on their absorptive capacity; iv. Requiring KNSI Actors to collaborate as a function of Government support; and, v. Requiring Government to fund KBI R&D on the basis of inter-disciplinary collaboration and triangulation.

Policy Implication	Specific Implications	Policy Recommendations
Availability of Policy Instruments & Success		
Need to recalibrate fiscal and monetary policies to make Tax Breaks, Government-Backed Venture Capital, and Subsidised Loans effective.	i. Fiscal and monetary policy instruments need configuring and recalibrating, consistent with WTO non-actionable subsidies , in order to accelerate innovativeness and innovation; and ii. The policy instruments that require most urgent reconfiguration and recalibration to address and overcome barriers to innovation are: Fiscal (Tax Breaks) arrangements (to enable economy-wide innovativeness and innovation by, for example, altering capital depreciation regulations), Subsidised Loans (to enable KBI to engage in patenting, incubating new ideas, spin-offs from IPRs, generating medium-and high-tech SMEs within university campuses, engaging with MHTI for R&D and product development, earning license and royalty fees, and full-blown commercialisation of research outcomes), and Government-Backed Venture Capital (to engender innovativeness and innovation in the private sector.	i. R&D tax credits, as an incentive for business R&D rates of relief to be adjusted upwards for SMEs in MHTI; reductions in the wage taxes of R&D personnel in KBIs and MHTI (especially SMEs in MHTI); ii. Initiating a STEMIT research tax incentive programme; iii. Initiating a competitive STEMIT business scholarship programme for post-graduate and post-doctoral researchers to commercialise their research; iv. Reconfiguring and recalibrating tax treatment of share options in spin-offs and start-ups to attract experienced managers; and, v. Using Government-Backed Venture Capital to guarantee loans; and vi. Recoding the inward FDI regime to require the investor to invest (Equity, Joint Ventures) in SMEs in MHTI, as part of the conditionalities for market entry in exchange for fiscal advantages available to the investor.
Latent Factors to Policy Success		
Reconfiguration and recalibration of policy instruments towards performance based measures.	The policy implications that arise are: i. Two key dimensions of policy craft, <<Regulatory>> and <<Financial>>, conform the successful combination of policy instruments in terms of fiscal, monetary, regulation, standards and performance requirements; ii. <Monetary and Fiscal Support> and its permutations (according to KNSI Actors) directed to the Actors in the KNSI need to be reconfigured and recalibrated in the light of the systemic failure of policy instruments identified; iii. <ICT Regulatory Standards-Based Support> and its permutations (according to KNSI actors) required reconfiguration and recalibration in order to sustain, and accelerate the performance of the KNSI; iv. In return for providing explicit, enshrined in law, support Government would need to demand that KNSI Actors meet performance requirements that are encouraged by incentives and sanctions; v. A judicious policy mix of direct and indirect support measures are requisite; vi. The fiscal and monetary regime relevant to innovation and innovativeness would need to be audited for 'fitness-for-purpose' with respect to the KNSI; and, vii. Regulatory support to innovation in general and to the KNSI specifically would need to be audited for 'fitness-for-purpose'.	The policy recommendations to support the <<Regulatory>> and <<Financial>> dimensions of policy success include: i. Selecting a mix of newly reconfigured and recalibrated financial instruments (backed to differing extents by Government) ; ii. Selecting a mix of tax incentives; iii. Using a sovereign wealth fund (expected from future hydrocarbon revenues) to support direct financial interventions on a massive scale; iv. Selecting a mix of demand-side instruments (public procurement, standards setting, regulations, lead markets) to drive policy success; v. Adopting regulations, especially environmental, that use performance and technology based rules; vi. Adopting regulatory incentives for incremental improvements; and, vii. Setting higher resolution standards oriented toward consumer protection.
Effectiveness of the KNSI		
Without BEs-BEs and RIs-PS linkages the effectiveness (and innovativeness) of the KNSI is hobbled.	The policy implication of strengthening BE-BE linkages is a greater ability to tap into and exploit stocks and flows of knowledge within the MHTI Actor group, thus increasing the effectiveness of the NSI.	i. Enabling logistics quality and competence to increase by 'atomising' the completion for logistics on the back of critical improvements in infrastructure; ii. GoK support to KBIs (HE and RI) to be increasingly contingent on performance requirements of; triangulation with MHTI (BEs) and ARBs, KBIs generating IPRs from R&D in STEMIT to be intermediated to MHTI (BEs) by ARBs, and RI to be required to seek an increasing proportion of their funds from MHTI (BEs); iii. GoK support to R&D intense MHTI (BEs) to be increasingly oriented to enabling BEs to use KBIs (HE and RIs) in their innovative activities through changes to the tax system to enable write-offs against R&D contracted to KBIs for example; and iv. GoK supporting BEs in standing conferences involving businesses and industry associations and chambers of commerce.

Policy Implication	Specific Implications	Policy Recommendations
Efficiency of the KNSI		
Without Actor intra- and inter-linkages and innovativeness of BEs the efficiency of the KNSI is hobbled.	The policy implications are oriented around the strengthening of Actor linkages. Specifically, the enhancement of the inter-linkages among RIs and between Business Enterprises and Arbitrageurs would improve the efficiency of the NSI. The policy implications of strengthening RI-RI linkages are that there is a greater ability to tap into and exploit stocks and flows of knowledge within the group, thereby enhancing the efficiency of the NSI	i. Applying performance requirements to KBIs (HE, RIs) to formalise inter-linkages, with output KPIs, through co-research, joint applications (maximum three consortia) for research grants, consortia for Government tendering, and standing biennial conferences with MHTI for exhibiting IPRs; ii. Establishing a central IPR office for RIs; iii. Conditioning all research awards and grants on the production and commercialisation of minimum three IPRs; iv. Condition research awards and grants to RIs on at least one incubated spin-off; v. Condition Government direct and indirect support to KBIs, FIs and VC on triangulation ARBs-KBIs-MHTI; vi. Ensure ARBs representation on KNSIPU; vii. Legislate formal consultation by Government with FIs and VC on policy matters concerning the KNSI; viii. Use Government controlled VC and development bank facilities to triangulate with ARBs and RIs; ix. Mandate Government controlled VC to stipulate a percentage of portfolio for RIs incubated spin-offs; x. Instigate performance requirements concerning research and grants, part of which should be matched by funds from ARBs with respect to output IPRs and spin-off commercialisation; xi. Use fiscal regime to increase BE-ARBs inter-linkages by allowing write-offs against commercialisation of KBI(HE, RI) IPRs by BEs, part funded by ARBs; xii. Alter depreciation rates to permit accelerated capital for labour substitutions; xiii. Use fiscal and monetary incentives to accelerate the rate of skills upgrading in MHTI BEs; xiv. Condition direct and indirect support to MHTI BEs on KBI (HE RIs) subcontracted by MHTI BEs for a percentage of the product development portfolio; xv. Condition direct and indirect support to MHTI BEs on their sponsoring specific RIs; and xvi. Reconfigure the inward FDI regime to require investors to formalise joint ventures with RIs.

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Annex I - Importance of Actor and Strength of intra-Linkages

Importance of Government										
	All actors %n		Government %n		Industry %n		KBIs %n		Arbitrageurs %n	
Linkage	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W
GOV-GOV	58.2	37.3								
GOV-ISTC			84.5	11.5						

Importance of Institutions Supporting Technical Change (ISTC)										
	All actors %n		Government %n		Industry %n		KBIs %n		Arbitrageurs %n	
Linkage	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W
GOV-ISTC			84.6	11.5						

Importance of Higher Education System										
	All actors %n		Government %n		Industry %n		KBIs %n		Arbitrageurs %n	
Linkage	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W
HE-HE	67.2	28.8	92.3	3.8						
HE-RI	17.2	78.2					59.1	37.7		

Importance of Research Institutions										
	All actors %n		Government %n		Industry %n		KBIs %n		Arbitrageurs %n	
Linkage	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W
RI-RI	66.1	29.5					68.4	28.6		
RI-HE	49.9	45.6					54.8	42.0		

Importance of Business Enterprise										
	All actors %n		Government %n		Industry %n		KBIs %n		Arbitrageurs %n	
Linkage	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W
BE-BE	59.7	34.6			28.3	32.0				

Importance of Financial Institutions										
	All actors %n		Government %n		Industry %n		KBIs %n		Arbitrageurs %n	
Linkage	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W
ARB-ARB			53.9	38.4						
ARB-FI			61.6	30.8						

Importance of Arbitrageurs										
	All actors %n		Government %n		Industry %n		KBIs %n		Arbitrageurs %n	
Linkage	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W	I-S	I-W
ARB-ARB	41.8	35.5								
ARB-FI	43.7	33.6	61.4	30.8						

Annex II - List of Government Ministries

Ministries

Department of Agriculture
Department of Commerce
Department of Education
Department of Fisheries
Department of Infrastructure
Department of Livestock
Department of Science and Technology
Department of Tourism
Department of Transport Services
Ministry of Defence
Ministry of Environment, Water and Natural Resource
Ministry of Foreign Affairs
Ministry of Health
Ministry of Agriculture, Livestock and Fisheries
Ministry of Devolution and Planning
Ministry of East African Affairs, Commerce and Tourism
Ministry of Education
Ministry of Energy and Petroleum
Ministry of Industrialization and Enterprise Development
Ministry of Information, Communication and Technology
Ministry of Interior and Coordination of National Government
Ministry of Labour, Social Security and Services
Ministry of Land, Housing and Urban Development
Ministry of Mining
Ministry of Sports, Culture and the Arts
Ministry of the National Treasury
Ministry of Transport and Infrastructure

Committees

Committee on Agriculture, Land and Natural Resources
Committee on Education and Technology
Committee on Energy Roads and Transport
Committee on Legal Affairs and Human Rights
Committee on National Security and Foreign Relations

Parastatals

Kenya ICT Board
Kenya Institute of Education
Kenya National Bureau of Statistics

Committee on Subsidiary Legislation
Public Accounts Committee
Standing Orders Committee

Annex III - List of Knowledge-Based Institutions

Universities and Colleges

Adventist University of Africa
Africa International University
Africa Nazarene University
Africa Nazarene University
African Institute of Research and Development Studies
Aga Khan University Teaching Hospital
Airways Travel Institute
Alphax College
Augustana College
Australian Studies Institute (AUSI)
Bandari College
Baraton Teachers' Training College
Bell Institute of Technology
Bungoma Technical Training Institute
Career Training Centre
Catholic University of Eastern Africa (CUEA)
Chuka University
Coast Institute of Technology
College of Management Sciences
Compuera College
Computer Pride Training Centre
Computer Training Centre
Computers for Schools Kenya Training Institute
Consolata Institute of Communication and Technology
Cornerstone Training Institute
Daystar University
Dedan Kimathi University of Technology
Digital Age Institute
Eagle College of Management Studies
East Africa Institute of Certified Studies
East Africa School of Journalism (EASJ)
East African Media Institute (EAMI)
East African School of Aviation
Egerton University
Eldoret Aviation Training Institute
Eldoret Polytechnic
Elite Centre
Esmart College
German Institute of Professional Studies
Government Training Institute (GTI)-Mombasa
Government Training Institute (GTI)-Nairobi
Graffins College
Great Lakes University of Kisumu
Gretsa University
Gusii Institute of Technology
Inoorero University
Institute of Advanced Technology
Institute of Information Technology Studies & Research
International Centre of Technology
International Hotel & Tourism Institute
Interworld College
Intraglobal Training Institute
Jogoo Commercial College
Jomo Kenyatta University Of Science And Technology (JKUAT)
Kabarak University
Kabete Technical Training Institute,
Kagumo Teachers Training College
Kaiboi Technical Training Institute
Kamagambo Adventist Teachers Training College
Kca University
Kenya Aeronautical College (Aviation, Engineering & Cabin Crew)
Kenya Christian Industrial Training Institute (KCITI)
Kenya College of Medicine & Related Studies
Kenya Education Management Institute (KEMI)
Kenya Forestry College
Kenya Institute of Applied Sciences
Kenya Institute of Biomedical Sciences and Technology
Kenya Institute of Business and Technology
Kenya Institute of Development Studies
Kenya Institute of Management (KIM),
Kenya Institute of Mass Communication
Kenya Institute of Media and Technology (KIMT)
Kenya Institute of Professional Studies - Nairobi
Kenya Institute of Social Work and Community Development (KISWCD)
Kenya Institute of Special Education (KISE)
Kenya Medical Training Centre (KMTC)
Kenya Methodist University
Kenya School of Monetary Studies
Kenya Science Teachers College
Kenya Technical Teachers College
Kenya Utali College
Kenya Water Institute
Kenya Wildlife Service Training Institute
Kenyatta University
Kericho Teachers College
Kiambu Institute of Science and Technology
Kilimambogo Teachers College
Kima International School of Theology (KIST)
Kiriri Women's University of Science and Technology
Kisumu Polytechnic
Kitale Technical Institute
Machakos Institute of Technology
Maseno University
Masinde Muliro University of Science and Technology
Mawego Technical Institute
Meru Technical Institute
Migori Teachers College

Moi Institute of Technology
Moi University
Mombasa Technical Training Institute (MTTI)
Mosoriot Teachers College
Mount Kenya University
Multimedia University College of Kenya
Murang'a Institute of Technology
Nairobi Aviation College
Nairobi Institute of Business Studies
Nairobi Institute of Technology
Nairobi Technical Training Institute
Naivasha Computer & Business Studies College
Nakuru College of Health Sciences and Management
Narok Teachers College
National Youth Service Engineering Institute
Nkabune Technical Training Institute
Oshwal College
Pan Africa Christian University
Pioneer's Training Institute
Premese Africa Development Institute
Premier College Of Hospitality and Business Studies
Premier College of Professional Studies Ltd
Presbyterian University of East Africa
Pwani University
Railway Training School
Ramogi Institute of Advanced Technology
Regional Centre for Tourism and Foreign Language
Riara University
Riccatti Business College of East Africa
Rift Valley Institute of Science & Technology
Rift Valley Technical Training Institute
Royal College Of Science and Technology
Sagana Institute of Technology
Samsung Engineering Academy
Shanzu Teachers College
Shepherds Foundation Education & Research Centre
Skynet Business College
Sma Swiss Management Academy
St Joseph's Medical Training College
St. Marks Teachers Training College
St. Paul's University
Starnet College
Stonebic College
Strathmore University
Tambach Teachers Training College
Tangaza College
Tec Institute of Management
Technical University of Kenya
Technical University of Mombasa
The Kenya College of Science and Technology
The Regional Institute of Business Management
Thika Technical Training Institute
Times Training Centre
Tom Mboya Labour College
United States International University (USIU)
Universal Group of Colleges
University of Eastern Africa
University of Nairobi
Uzima University College
Vision Institute of Professionals
Wang Point Technologies College of Information Technology
Western College of Hospitality and Professional Studies
Zetech College

Research Institutes

Africa Medical Research Foundation (AMREF)
African Center for Technology Studies
African Economic Research Consortium
African Energy Policy Research Networks Ltd
African Ideal Research Services Ltd
African Institute of Research and Development
African Population and Health Research Center
African Research and Resource Forum
Center for Agriculture and Biosciences International (CABI)
Center for Research and Technology Development
Center for Research in Therapeutic Sciences
Center for Training and Integrated Research (CETRAD)
Cofee Research Foundation (CRF)
Consortium for National Health Research
Ecolife Consortium Ltd
Ibm Research
Ihub Research
Impala Research Center
Infortrack Research and Consulting Ltd
Institute for Meteorological Training and Research
Institute of Health Policy Management Research
Institute of Primate Research/Kenya National Museum
Inter Region Economic Network (Iren)
International Center of Insects Physiology and Psychology (ICIPE)
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
International Livestock Research Institute (ILRI)
Italian Space Agency
Kenya Agricultural Research Institute (KARI)
Kenya Forestry Research Institute (KEFRI)
Kenya Industrial Property Institute
Kenya Industrial Research and Development Institute (KIRDI)
Kenya Institute of Education (KIE)
Kenya Marine and Fisheries Research Institute (KMFRI)
Kenya Medical Research Institute (KEMRI)
Kenya National Academy of Sciences
Kenya Plant Health Inspectorate Service (KEPHIS)
Kenya Research Program
Kenya Sugar Research Foundation (KESREF)
Kenya Tea Research Foundation (TRF)
Kenya Trypanomiasis Research Institute
Kenya Veterinary Board-Research Institutions
Kenya Wildlife Service
Kibwezi Forestry Research Institute
Lake Victoria Environmental Management Program
National Council for Science and Technology
National Environmental Management Authority (NEMA)
National Irrigation Board
Nokia Research Center
Permaculture Research Institute Kenya (PRI)
Strategic Public Relations & Research Institute
Tea Research Foundation (TRF)
Tegemeo Institute of Agricultural Policy and Development
The Dryland Research Training and Ecotourism Center
The Kenya Institute for Public Policy and Research And Analysis (KIPPRA)
Turkana Basin Institute
World Agroforestry Center

Annex IV - Enlarged Figures

Figure 9.3 *- Government Inter-, Intra-Linkages*

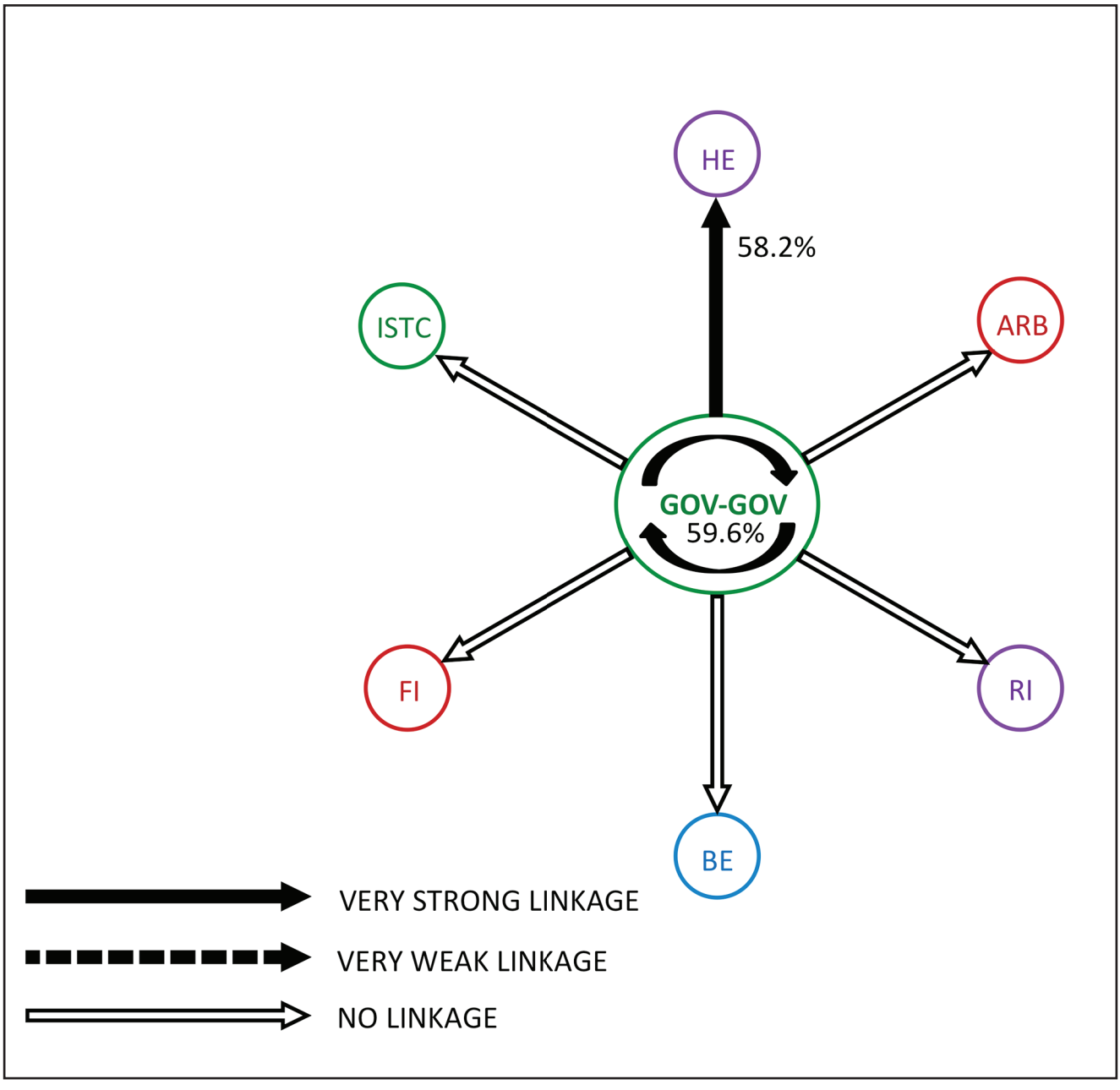


***Figure 9.4** - Government Assessment of Other Actors' Inter-Linkages*

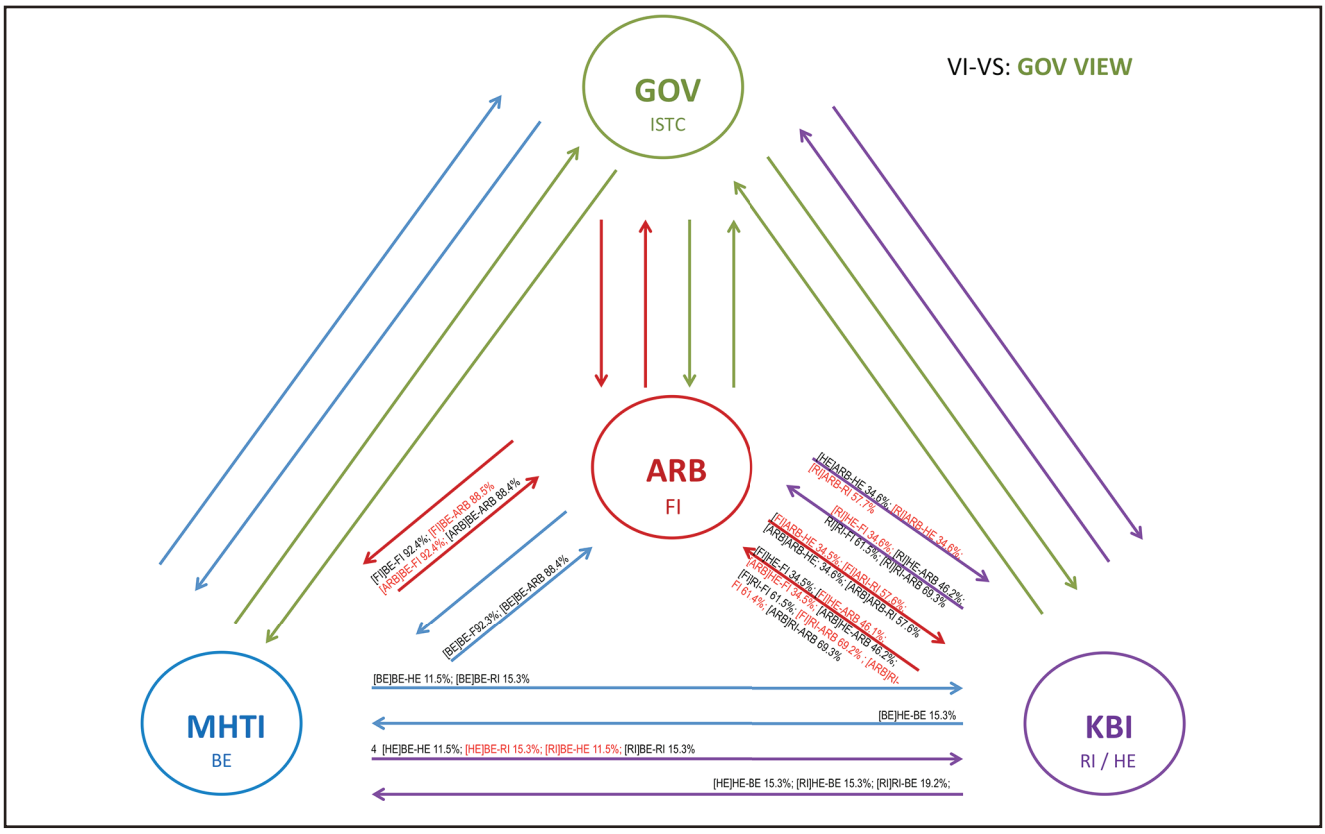


***Figure 9.5** – Business Enterprise Inter-, Intra-Linkages*

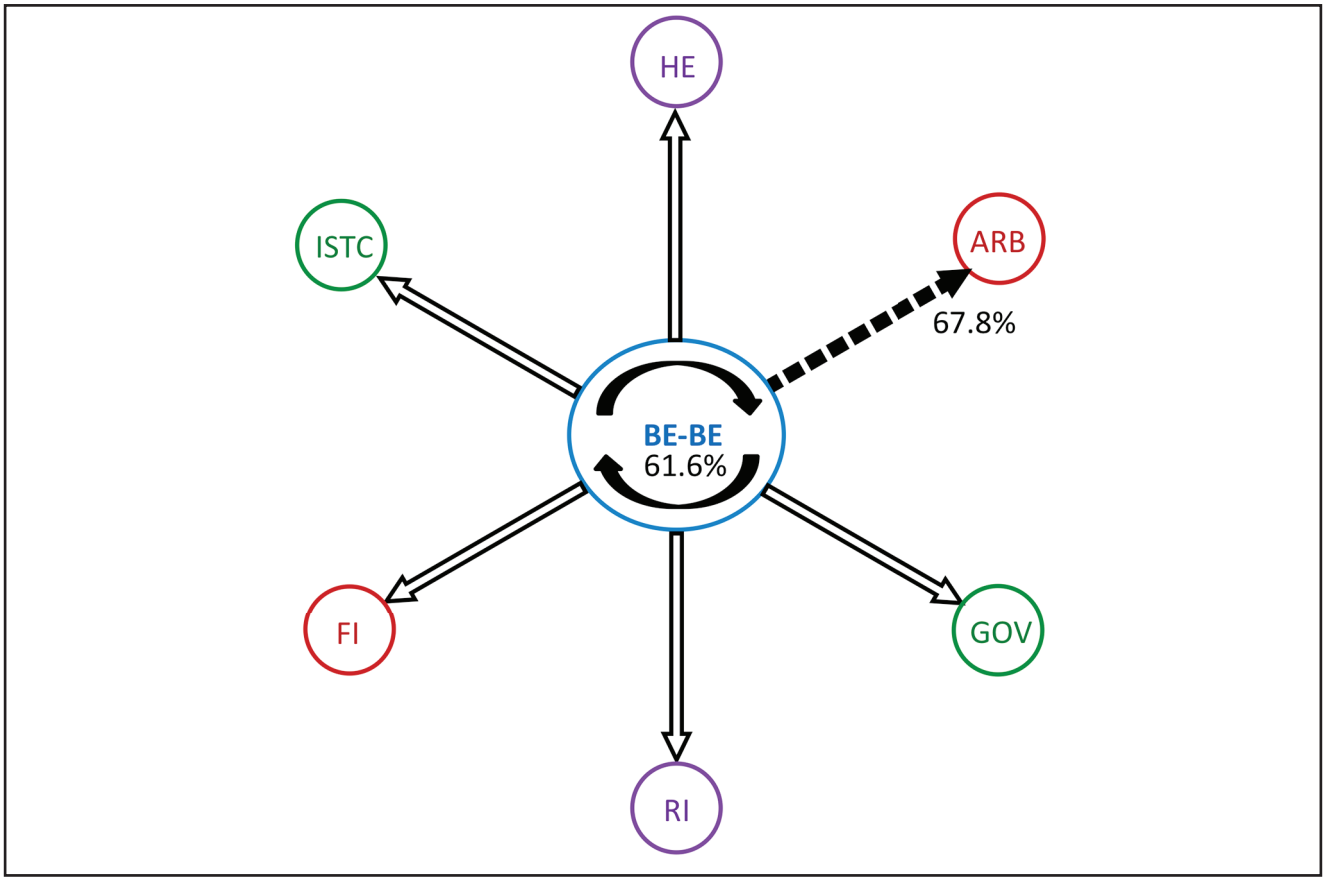


Figure 9.6 *- Medium and High-Tech Industry Assessment of Other Actors' Inter-Linkages*

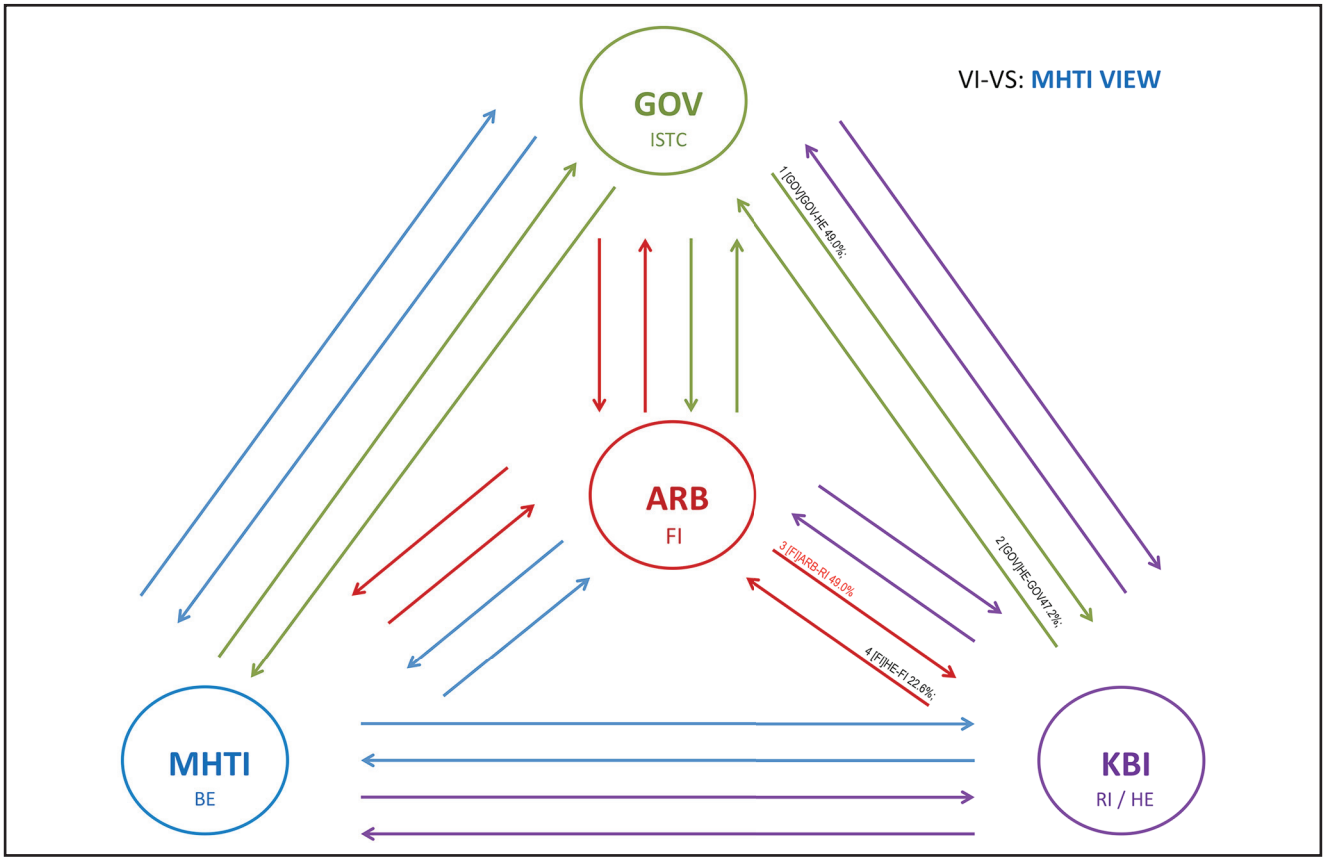


Figure 9.7 *- Higher Education Inter- Intra-Linkages*

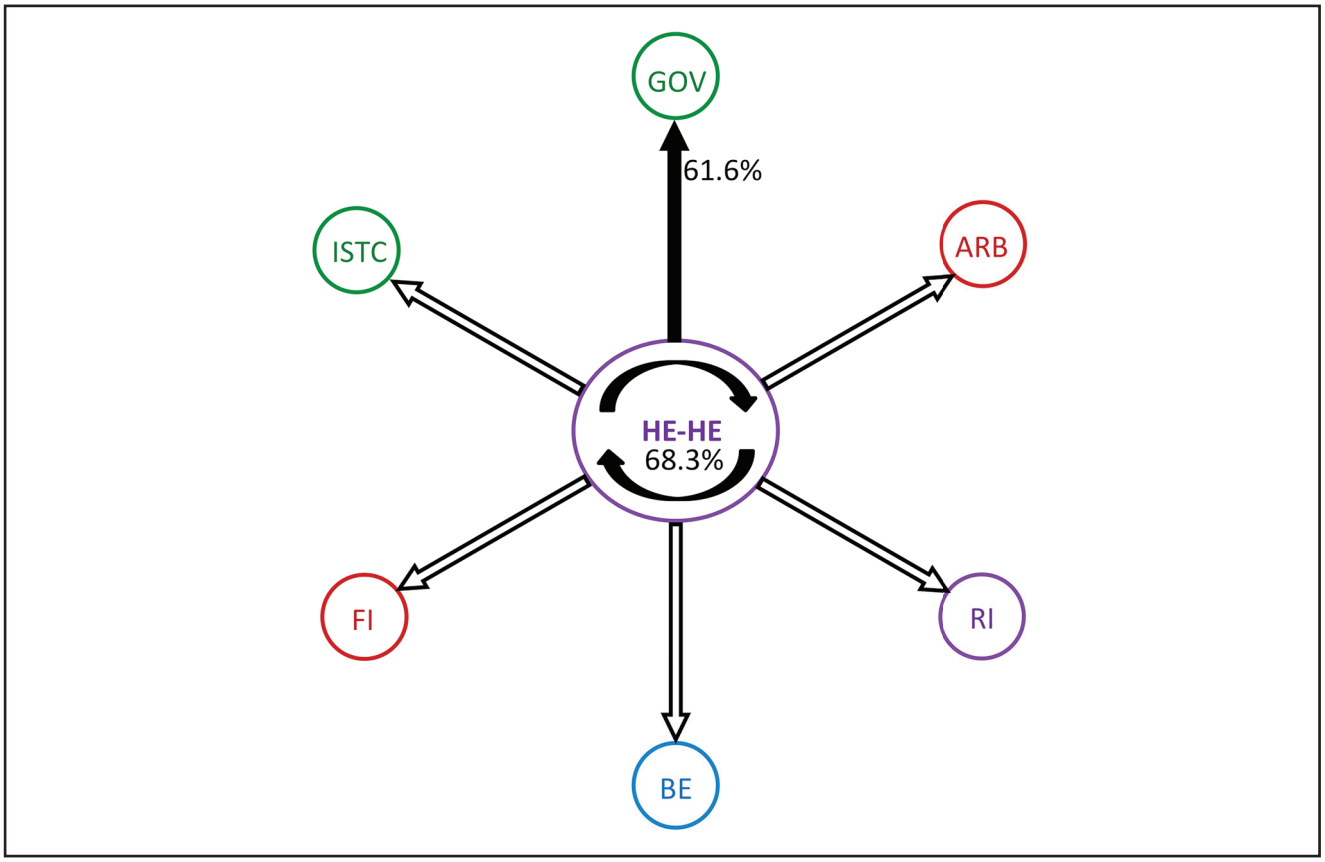


Figure 9.8 - *Research Institute Inter- Intra-Linkages*

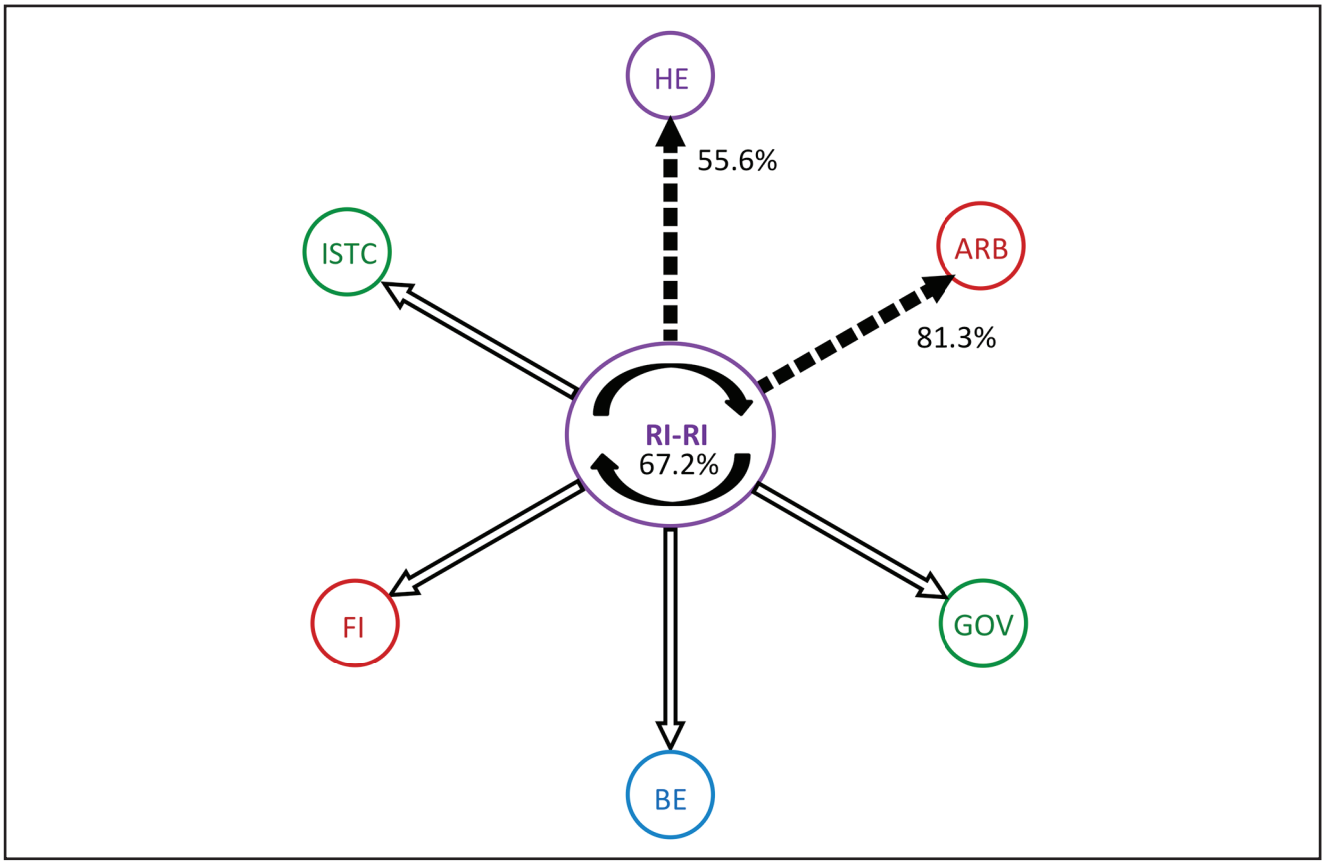


Figure 9.9 - *Knowledge-Based Institution Assessment of Other Actors' Inter-Linkages*

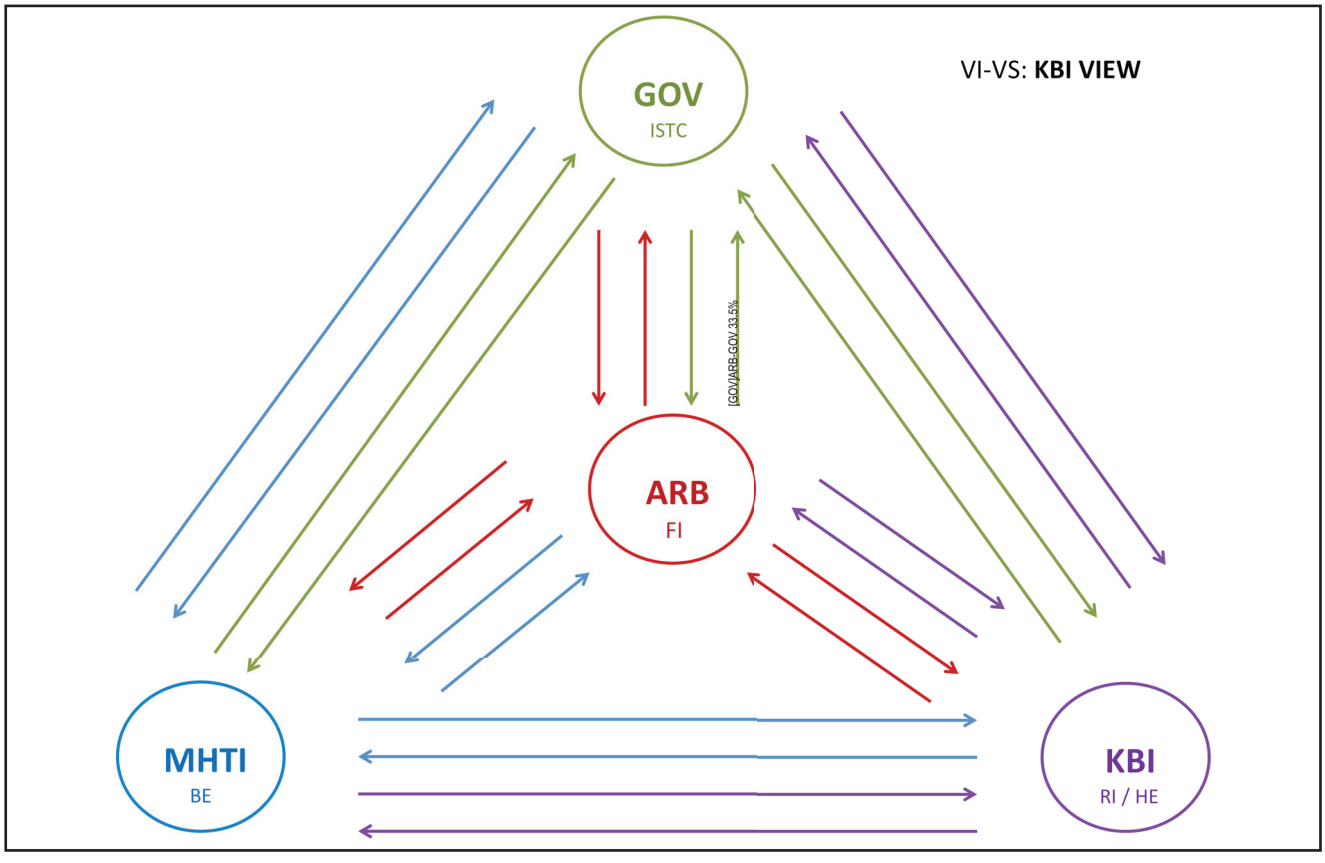


Figure 9.10 – *Arbitrageur Inter-, Intra-Linkages*

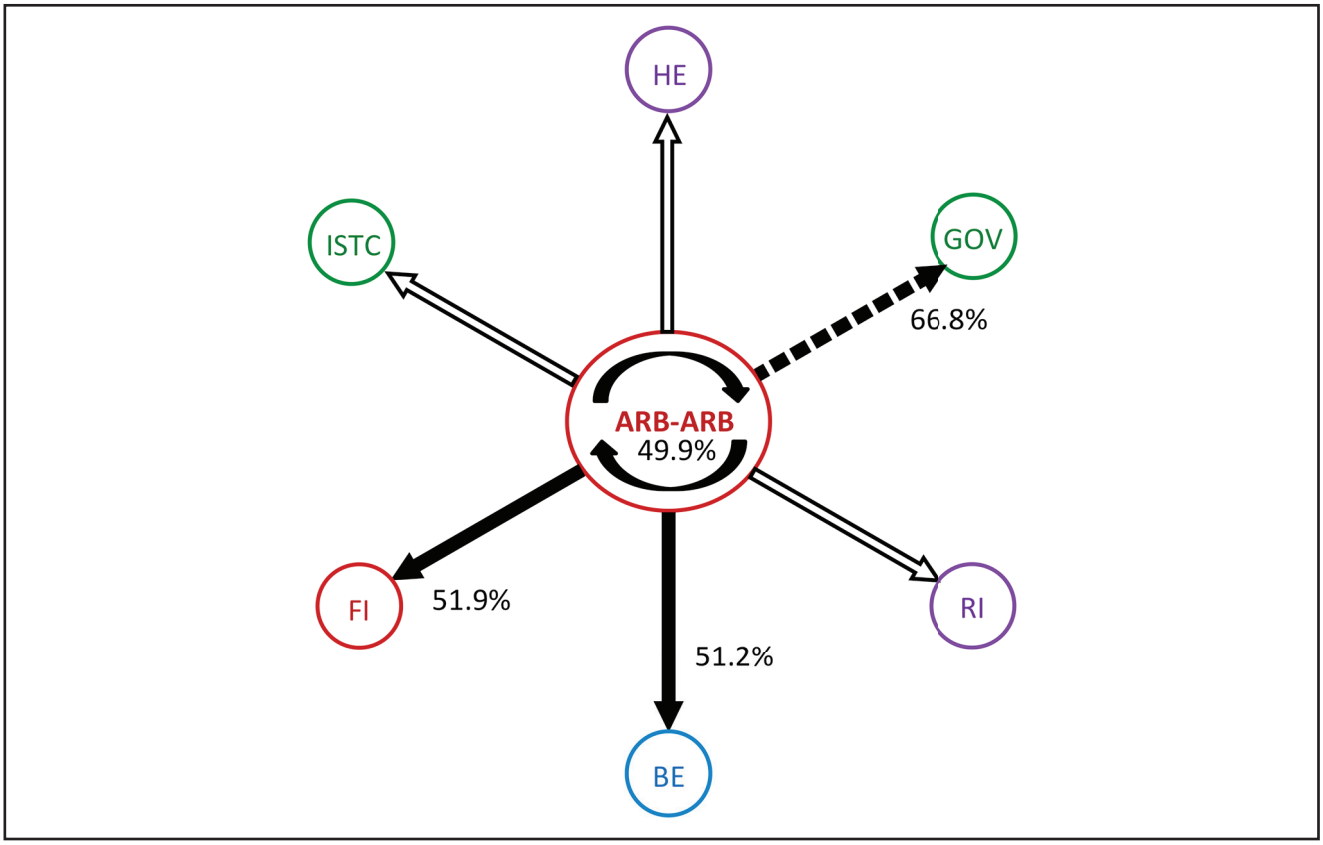


Figure 9.11 – *Arbitrageur Assessment of Other Actors' Inter-Linkages*

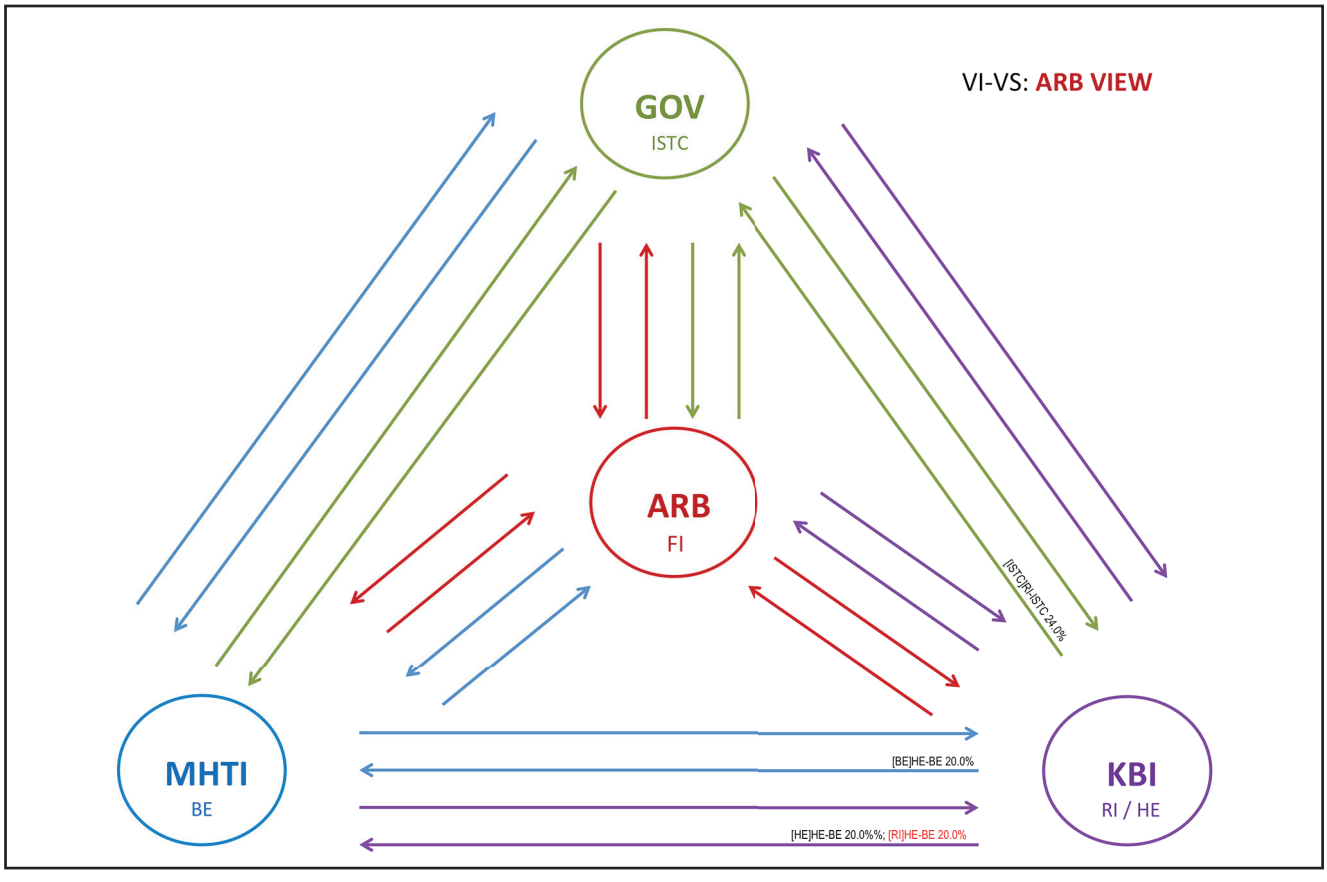


Figure 9.12 – *Actor-Centric Assessment of Inter Linkages (Very Important-Very Strong)*

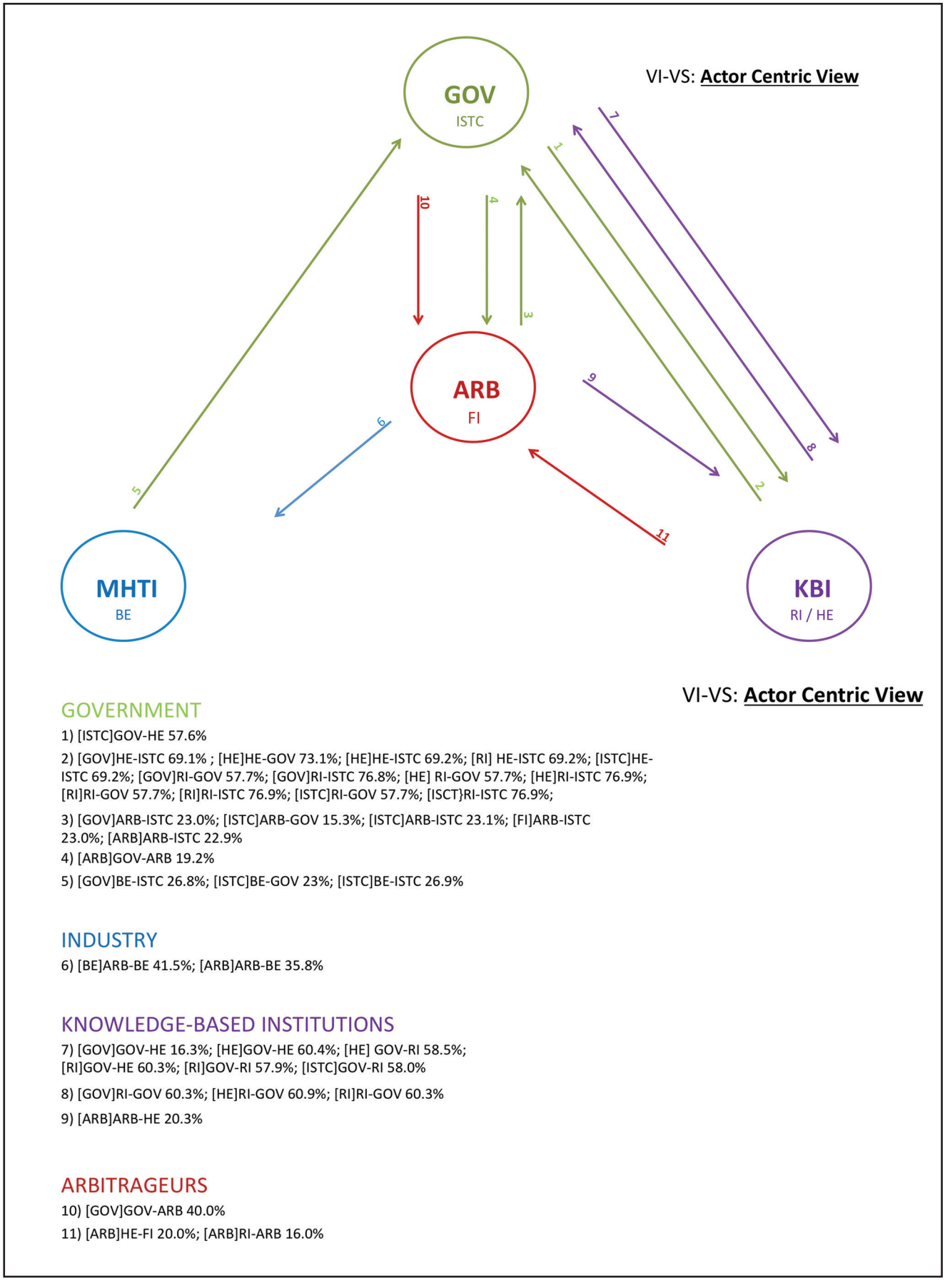
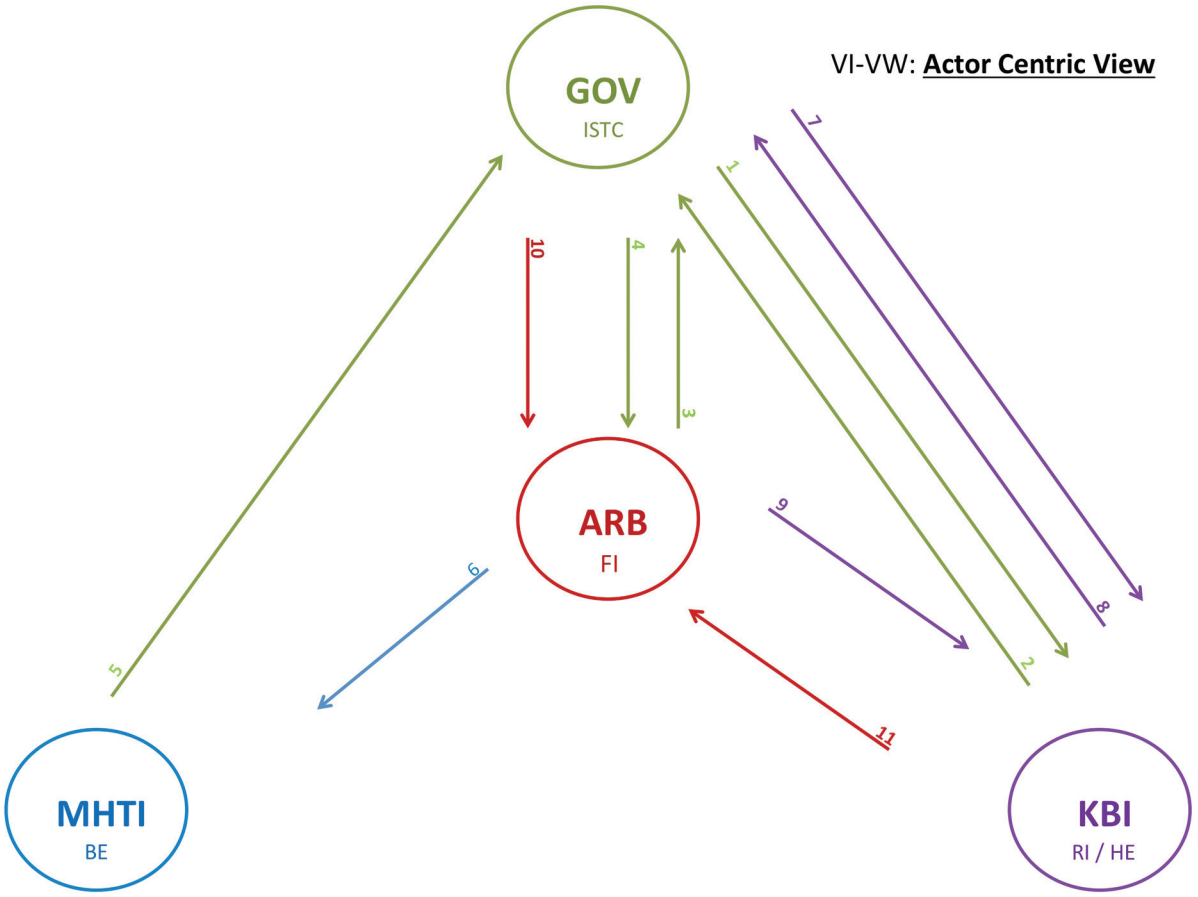


Figure 9.13 - Actor Centric Assessment of Inter Linkages (Very Important-Very Weak)



VI-VW: **Actor Centric View**

GOVERNMENT

1) [ISTC]GOV-HE 38.4%

2) [GOV]HE-ISTC 26.8% ; [HE]HE-GOV 23.0%; [HE]HE-ISTC 26.8%; [RI] HE-ISTC 26.8%; [ISTC]HE-ISTC 26.9%; [GOV]RI-GOV 38.5%; [GOV]RI-ISTC 19.2%; [HE] RI-GOV 38.5%; [HE]RI-ISTC 19.2%; [RI]RI-GOV 38.5%; [RI]RI-ISTC 19.1%; [ISTC]RI-GOV 38.5%; [ISCT]RI-ISTC 19.1%

3) [GOV]ARB-ISTC 73.1%; [ISTC]ARB-GOV 80.7%; [ISTC]ARB-ISTC 73.1%; [FI]ARB-ISTC 69.2%; [ARB]ARB-ISTC 69.2%

4) [ARB]GOV-ARB 69.2%

5) [GOV]BE-ISTC 69.1%; [ISTC]BE-GOV 73.0%; [ISTC]BE-ISTC 69.1%

INDUSTRY

6) [BE]ARB-BE 47.0%; [ARB]ARB-BE 18.9%

KNOWLEDGE-BASED INSTITUTIONS

7) [GOV]GOV-HE 36.6%; [HE]GOV-HE 36.5%; [HE]GOV-RI 38.5%; [RI]GOV-HE 36.5%; [RI]GOV-RI 39.0%; [ISTC]GOV-RI 38.9%

8) [GOV]RI-GOV 36.5%; [HE]RI-GOV 35.9%; [RI]RI-GOV 36.5%

9) [ARB]ARB-HE 59.2%;

ARBITRAGEURS

10) [GOV]GOV-ARB 52.0%

11) [AB]HE-FI 68.0%; [ARB]RI-ARB 72.0%

Figure 9.14 – *Government View of Linkages and Level of Innovativeness – VS-VHI*

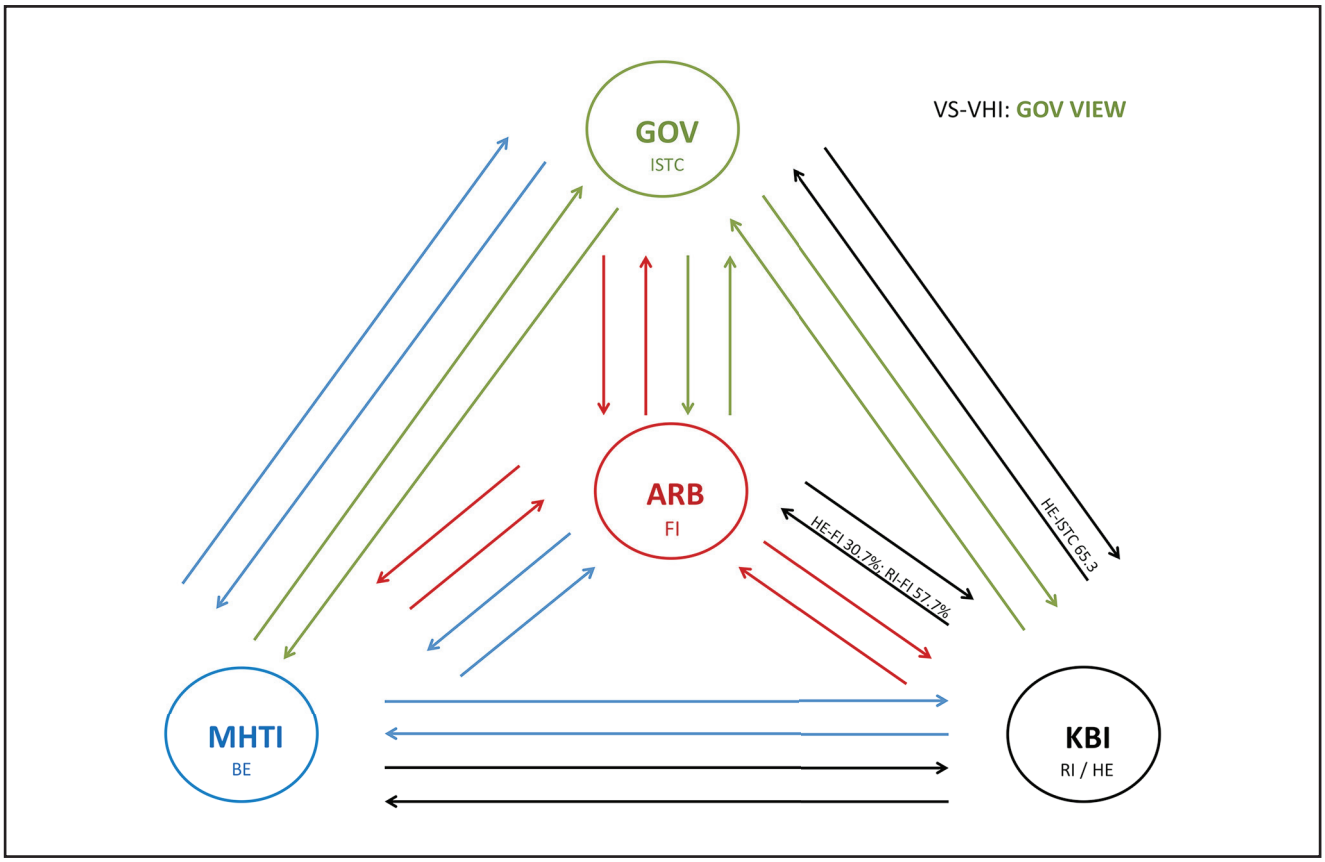


Figure 9.15 – Government View of Linkages and Level of Innovativeness – VS-VLI

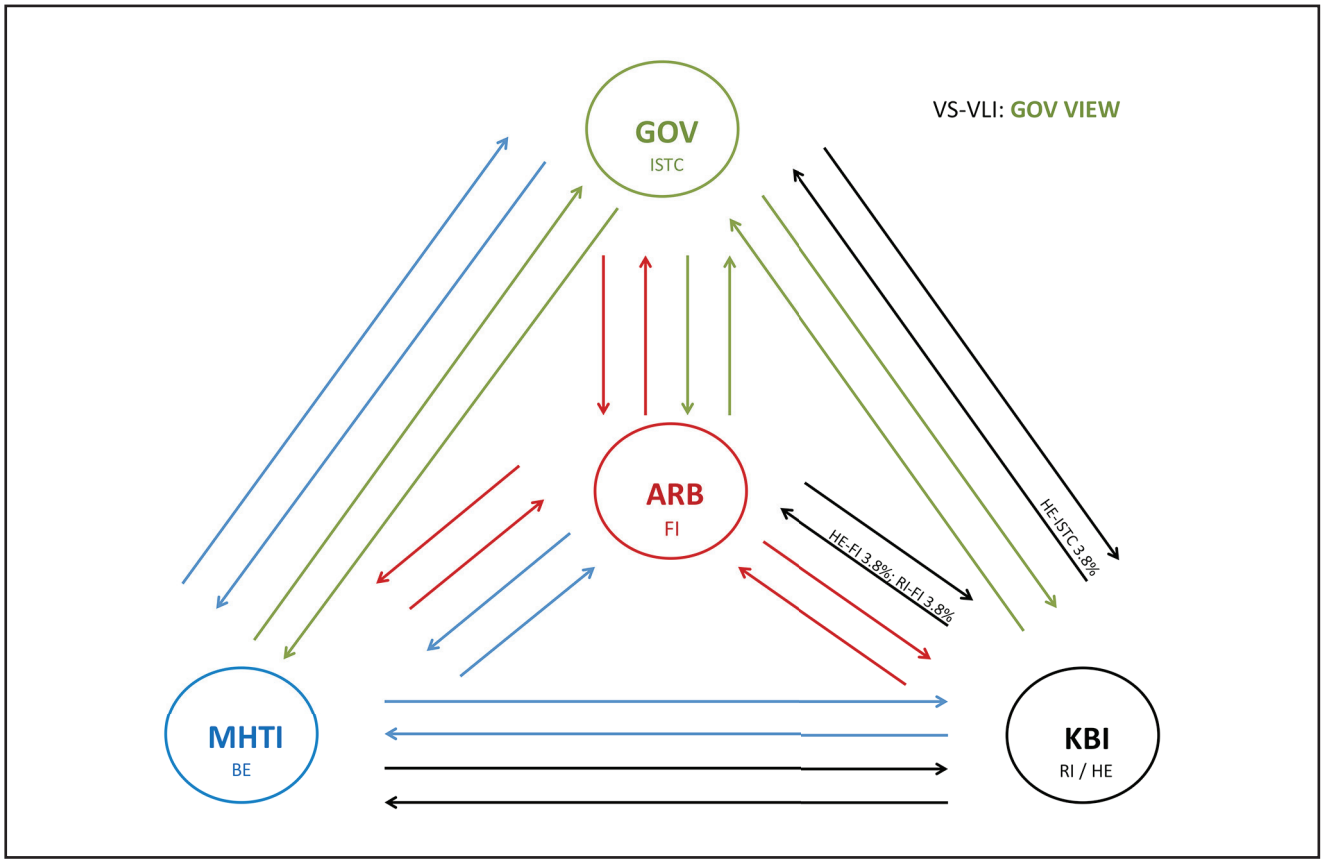


Figure 9.16 – *Medium and High-Tech Industry View of Linkages and Level of Innovativeness – VS-VHI)*

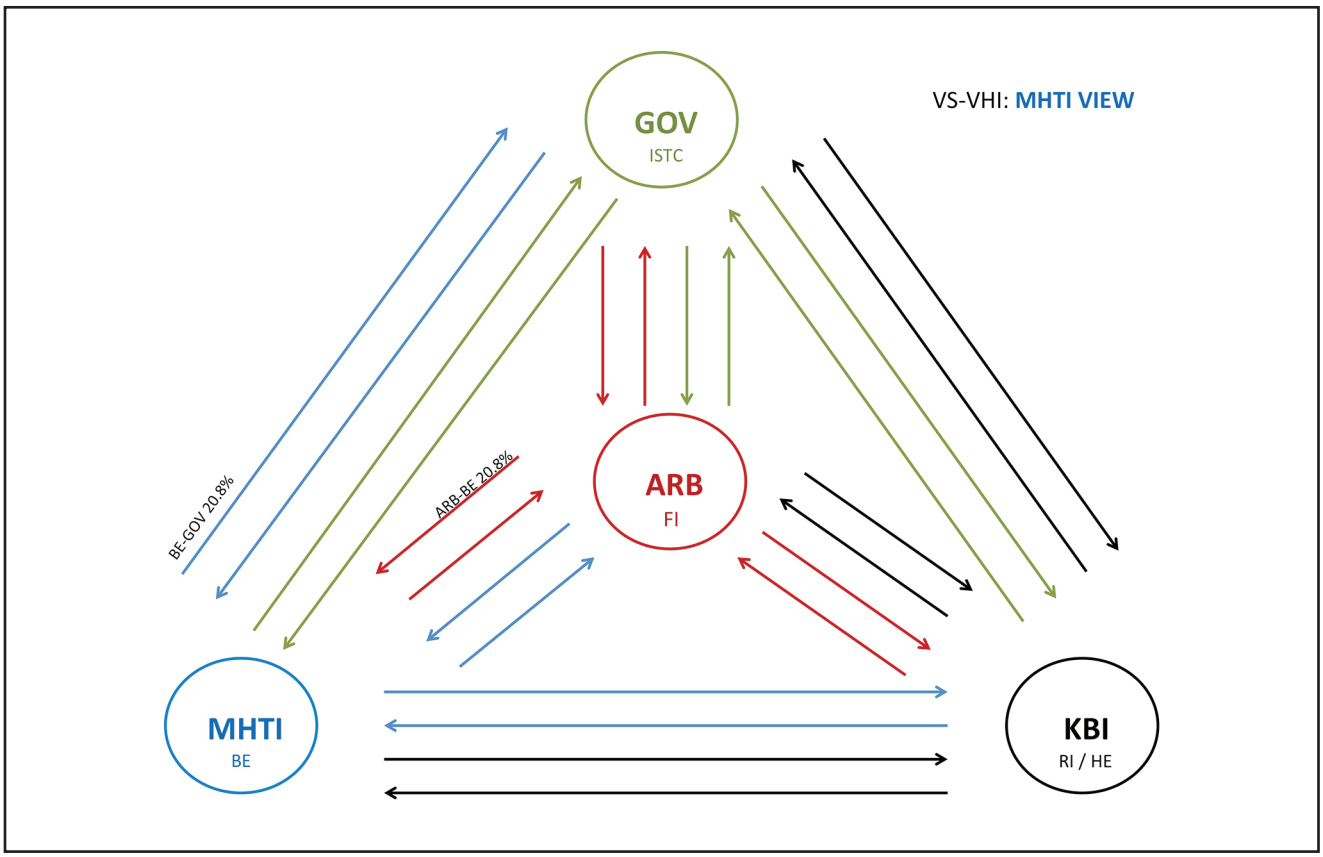


Figure 9.17 – *Medium and High-Tech Industry View of Linkages and Level of Innovativeness – VS-VLI)*

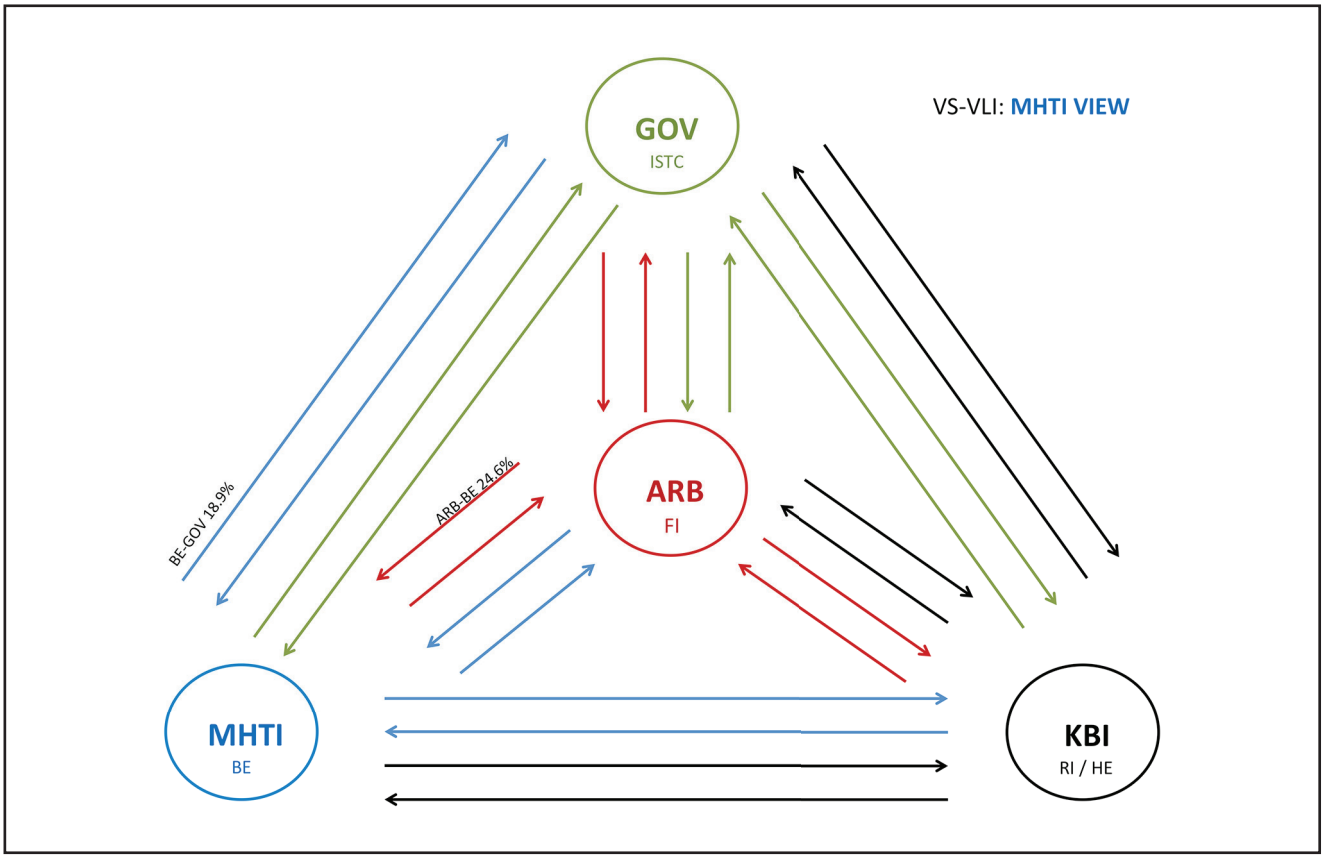


Figure 9.18 – *Knowledge-Based Institution View of Linkages and Level of Innovativeness – VS-VHI)*

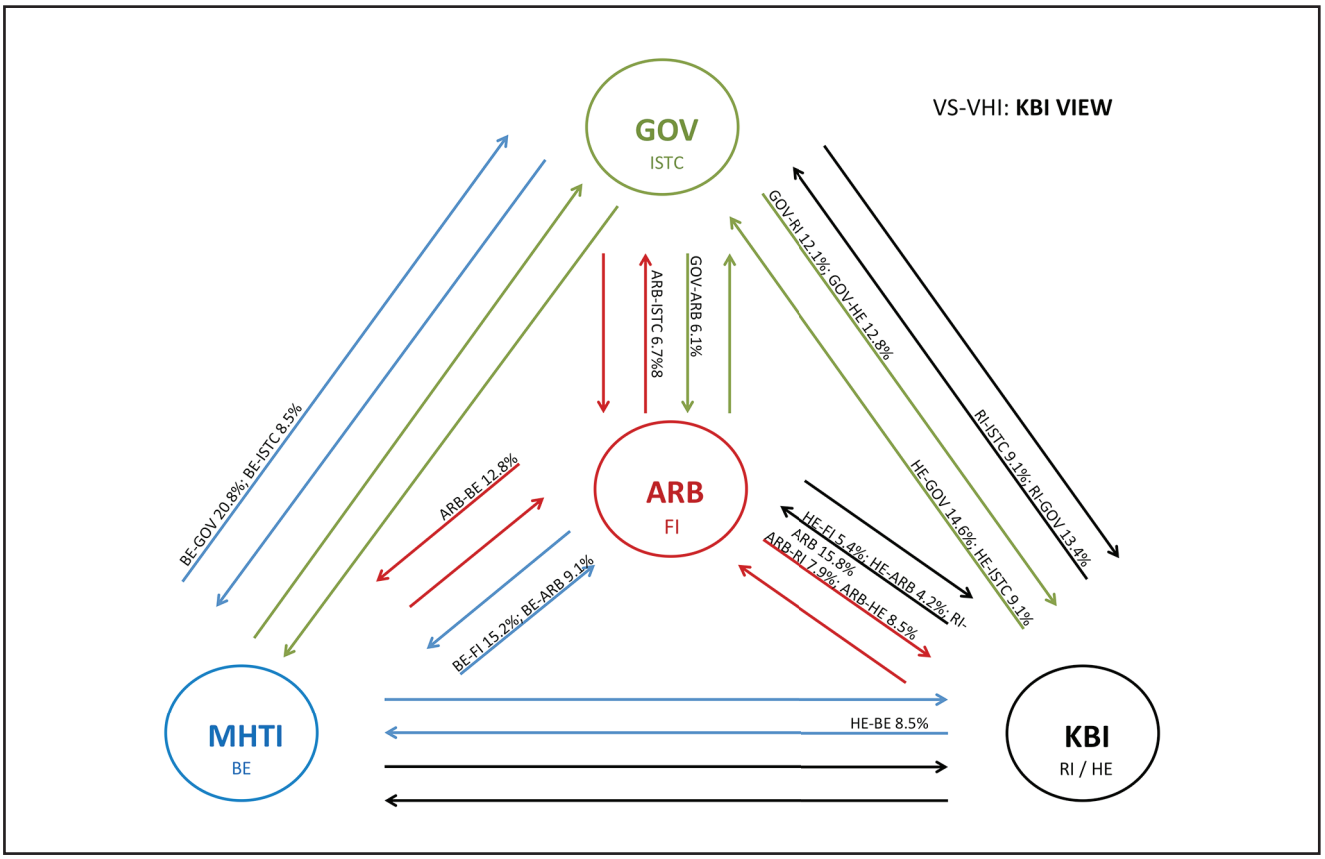


Figure 9.19 – *Knowledge-Based Institution View of Linkages and Level of Innovativeness – VS-VLI)*

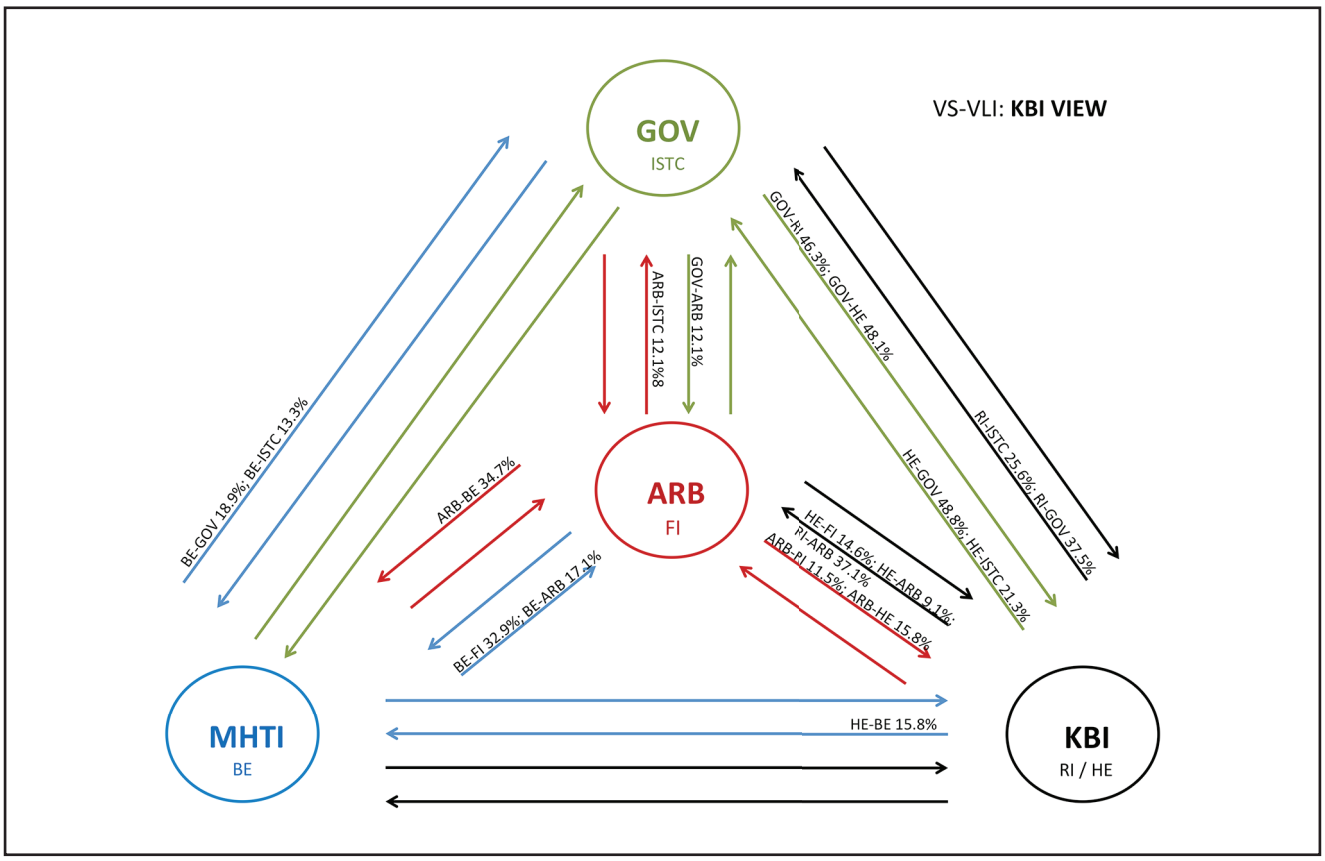


***Figure 9.20** – Arbitrageur View of Linkages and Level of Innovativeness – VS-VHI)*

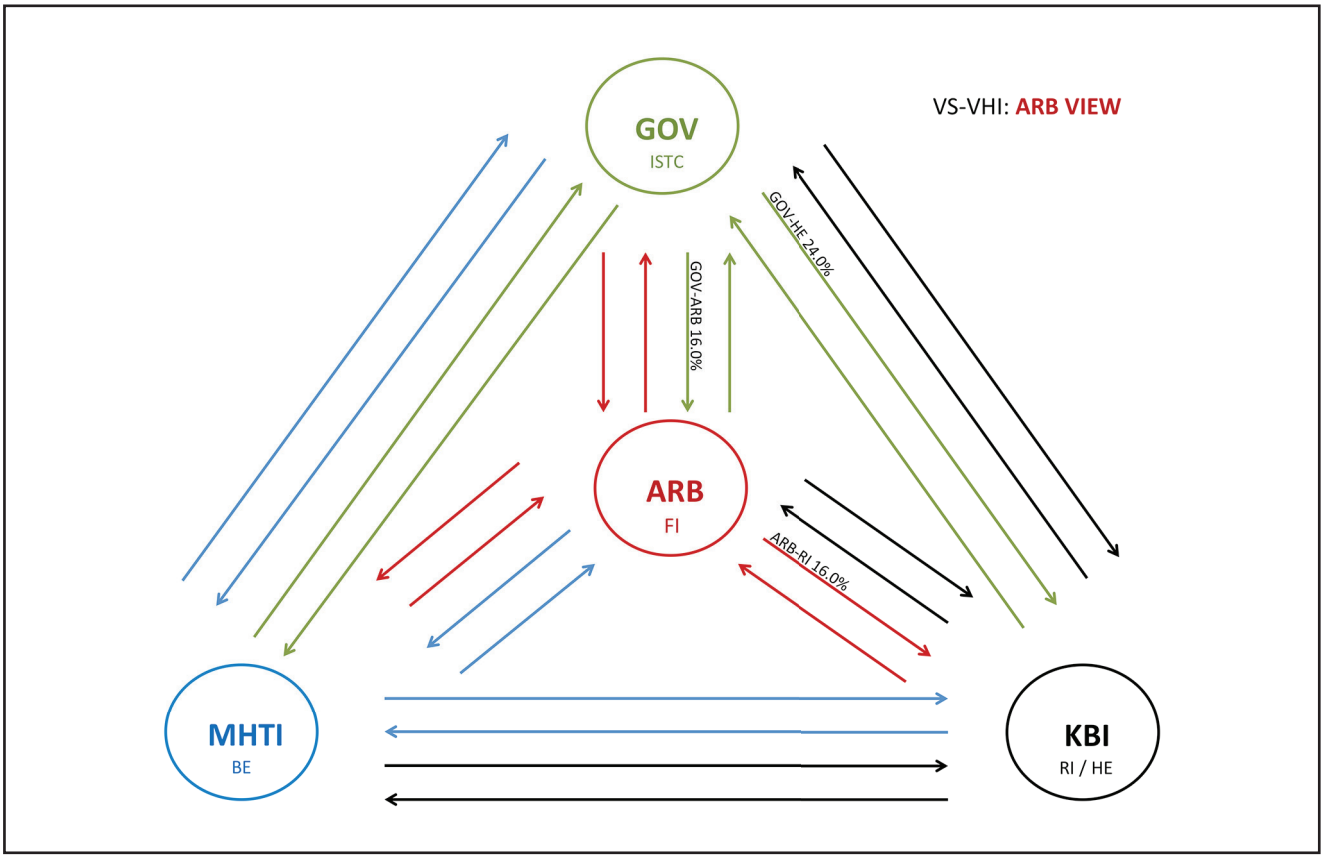
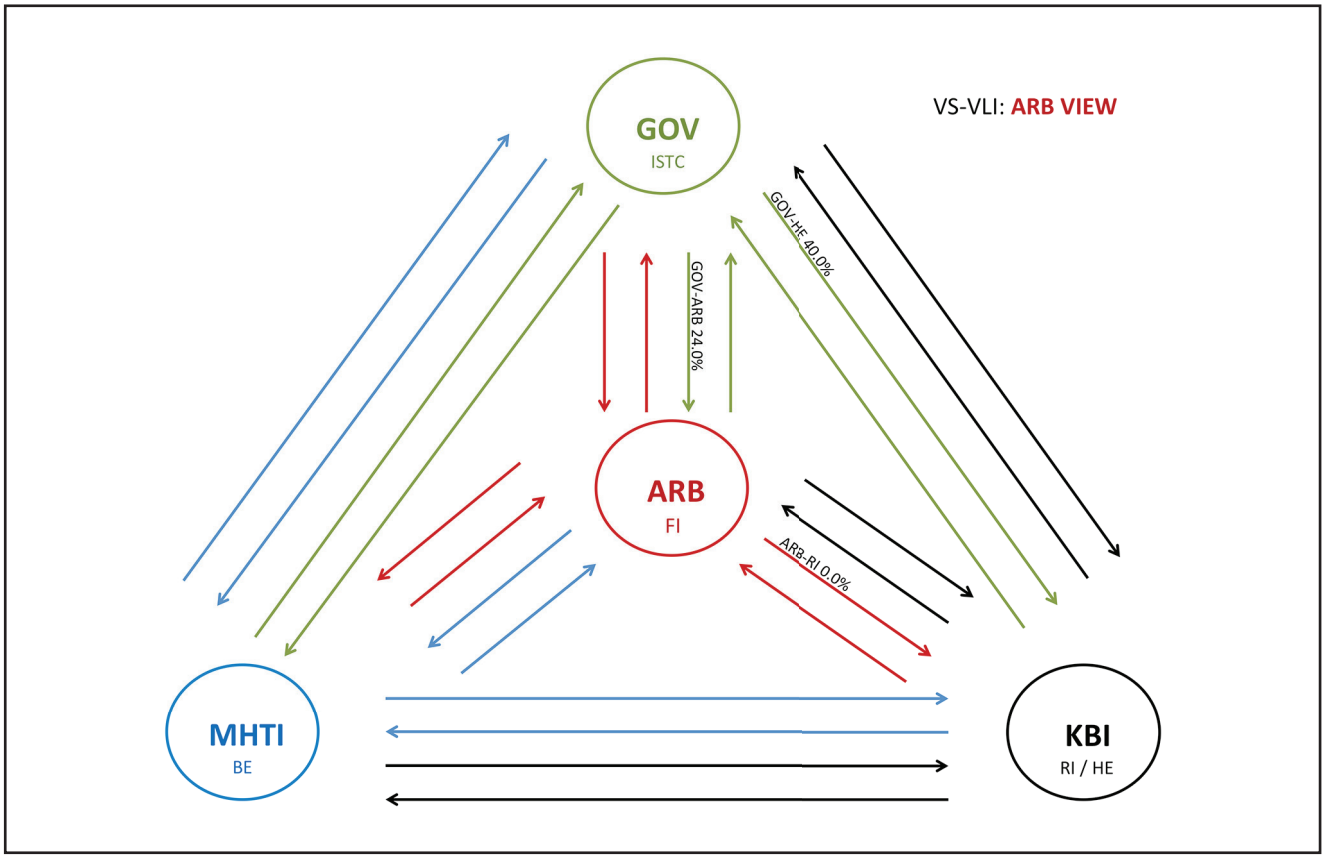


***Figure 9.21** – Arbitrageur View of Linkages and Level of Innovativeness – VS-VLI)*



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