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SCIENCE, TECHNOLOGY AND INNOVATION POLICY

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Revitalizing and Harnessing Science, Technology and Innovation in Kenya

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TABLE OF CONTENTS

FOREWORD	iii
ABBREVIATIONS AND ACRONYMS	iv
EXECUTIVE SUMMARY	vi
CHAPTER 1: INTRODUCTION	1
Background	1
Science, Technology and Innovation in National Development	1
Rationale for the STI Policy	2
Dimensions of the Policy.....	3
The Policy Development Process	3
CHAPTER 2: SITUATION ANALYSIS	4
Legal and Institutional Framework	4
Human Resource Development	5
Funding STI.....	6
Technology Development, Transfer and Diffusion	7
Infrastructure for Science, Technology and Innovation	8
Advocacy and awareness in STI	9
Collaborations and Partnerships in Science, Technology and Innovation	9
Gender Mainstreaming in STI	9
Performance Management.....	10
CHAPTER 3: SCIENCE, TECHNOLOGY AND INNOVATION POLICY FRAMEWORK	11
Vision.....	11
Mission.....	11
Goal	11
Philosophy.....	11
Guiding Principles	11
Policy Objectives	11
CHAPTER 4: POLICY STATEMENTS AND STRATEGIES	14
Legal and Institutional Framework	15
Human Resource Development	15
Education, Training and Research.....	16

Funding Science, Technology and Innovation.....	16
Technology Development, Transfer, Diffusion and Commercialization	17
Infrastructure for Science, Technology and Innovation	18
Collaborations and Partnerships in Science, Technology and Innovation.....	19
Gender Mainstreaming in STI	20
Performance Management Framework	21
CHAPTER 5: STI POLICY IMPLEMENTATION FRAMEWORK	22
Institutional Framework	22
Monitoring and Evaluation	23
Communication and Publicity	24
Policy Review	24
Implementation Matrix/Actions	25

FOREWORD

Kenya's Vision 2030 is founded on intensification in the application of science, technology, and innovation to raise productivity and efficiency levels across the three pillars. The Vision recognises the critical role played by research and development (R&D) in accelerating economic development in all the newly industrialising countries of the world. Kenya's national research institutes, universities and non-governmental institutions generate knowledge in different areas with varying levels of complexity. 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. New knowledge will play a central role in the nation's wealth creation and social welfare. Effective exploitation of knowledge is envisaged to provide a regime that will provide a package of incentives for the efficient use of the existing knowledge, creation of new knowledge, and flourishing entrepreneurship. An educated and skilled population will create, share, and use knowledge well in an effective innovation system at the research centres, universities, think tanks, private enterprises and community groups.

This Science, Technology and Innovation (STI) Policy is geared towards the realization of the Country's long-term development goal of Vision 2030. The object of the policy being to mainstream science, technology and innovation in all the sectors of the economy through carefully targeted investments. This will create a strong base for enhanced efficiency, sustained growth and promotion of value addition in goods and services. The Policy measures take into consideration the Government's focus implemented in the five-year Medium-Term Plans that articulate the priorities formulated to address the immediate needs for the period under implementation. This paves the way for a measurable, achievable and relevant purposeful application of science and technology in national growth and development.

The Policy implementation will require additional investment in STI, better coordination of actors, increased technology transfer, improved capability and capacities and increased collaborations among actors devoted to research, technical capabilities of the workforce, and in raising the quality of teaching mathematics, science, technology and engineering in schools, polytechnics and universities. There is also need to raise awareness and ensure that the objectives of this policy are understood and fully owned by the various stakeholders and implementing partners.

The process of policy development involved wide consultations with stakeholders, led by the National Commission for Science, Technology and Innovation (NACOSTI) who provided the needs of every sector and gave an indication of the direction we need to take in order to align research and development to national aspirations. There was public participation by way of workshops for research and development stakeholders from various public and private sector Institutions.

The Government is committed to the implementation of STI in Kenya and invites all actors to foster strong partnerships that will accelerate the pace of national development through adoption of technological and scientific processes and outputs.

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ABBREVIATIONS AND ACRONYMS

ASTII	Africa Science, Technology and Innovation Indicators
AU	African Union
CBC	Competence Based Curriculum
COE	Centre of Excellence
CoEP	Centres of Excellence Programme
CUE	Commission for University Education
FPE	Free Primary Education
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GER	Gross Enrolment Ratio
GOK	Government of Kenya
HEI	Higher Education Institutions
ICT	Information and Communication Technology
IPR	Intellectual Property Rights
IRTK	Indigenous Resources and Traditional Knowledge
KEBS	Kenya Bureau of Standards
KENIA	Kenya National Innovation Agency
KEPHIS	Kenya Plant Health Inspectorate Service
KES	Kenya Shillings
KNBS	Kenya National Bureau of Statistics
KNIS	Kenya National Innovation System
M&E	Monitoring and Evaluation
MDAs	Ministries Departments and Agencies
MOEST	Ministry of Education, Science and Technology
MSMES	Micro, Small and Medium Enterprises
MTP	Medium Term Plan
NACOSTI	National Commission for Science, Technology and Innovation
NEMA	National Environmental Management Authority
NEPAD	New Partnership for Africa's Development
NGOS	Non-Governmental Organizations
NIMES	National integrated Monitoring and Evaluation
NIS	National Innovation System
NRF	National Research Fund
PHD	Doctor of Philosophy
PMF	Performance Management Framework
PPP	Public Private Partnerships
R&D	Research and Development

RSTI	Research, Science, Technology and Innovation
S&T	Science and Technology
SDG	Sustainable Development Goals
STI	Science, Technology and Innovation
STEM	Science Technology Engineering and Mathematics
STISA	Science, Technology and Innovation Strategy for Africa
TVET	Technical Vocational Education and Training
UE	University Education

EXECUTIVE SUMMARY

Science, Technology and Innovation is identified as key foundation upon which the economic, social and political pillars of the Kenya Vision 2030 are anchored. The Vision further, proposes intensified application of STI to raise productivity and efficiency levels across the three pillars. The Vision also recognises the critical role played by research and development in accelerating economic development as in the newly industrialising countries. This STI Policy has therefore, been developed to support the implementation of Vision 2030 as well as Kenya's commitment to the attainment of the Sustainable Development Goals, the Africa Agenda 2063 and the targets of Science, Technology and Innovation Strategy for Africa (STISA), 2024.

The objectives of this Policy are to: guide the identification of S&T Sector priorities; rationalize and re-structure STI institutions; develop mechanisms for sustainable financial resource mobilization; enhance the quality and capacity of the human resource; re-align education and training programmes to national goals and industry needs; strengthen STI infrastructure; facilitate the development and growth of technology-based enterprises; and promote a culture of STI in the country.

The goal of the Policy is to facilitate transformation of the economy from a factor-based to a knowledge-based economy. The vision is "Accelerated transition to a knowledge-based economy" while the mission is to mainstream STI into all sectors through generation, acquisition, dissemination and utilisation of available capacities in order to achieve the objectives of the Kenya Vision 2030. The STI Policy is premised on the philosophy, "research for socioeconomic transformation, global competitiveness and sustainable development".

The development of this Policy was spearheaded by a multi-institutional technical team. It was highly consultative and participatory in approach. The process involved various stakeholders in S&T sector including the public sector, private sector, non-governmental organizations and development partners.

Through situation analysis, challenges which impede S&T sector performance were identified. These include: multiplicity of legislations in S&T sector with overlapping mandates and functions; weak policy framework to facilitate effective integration of STI into the national economy; relatively low R&D personnel; insufficient qualified staff to teach STEM related programs; non-alignment of education and training curricula to industry needs; low national R&D expenditure of 0.98% against the target of 2% of GDP; technological learning within the business system which is not formally structured and appropriately managed to ensure technology transfer; inadequate infrastructure in most public research institutions and universities; low levels of awareness on intellectual

property rights; inadequate STI data; inadequate and fragmented documentation and preservation of indigenous resources and traditional knowledge; and low science culture among the population.

The Policy identifies eight strategic issues which are addressed through nine policy interventions with corresponding strategies. The policy interventions commit the Government to: strengthen and harmonize the legal and institutional framework for the development and utilization of STI; build and develop human resource capital in STI to meet the demands of the economy; promote quality STEM education, training and research for a knowledge-based economy; mobilize resources for R&D; strengthen the Intellectual Property Rights Regime; promote development, transfer and diffusion of ideas and knowledge into products and processes; provide an enabling environment for sustainable utilization of Indigenous Resources and Traditional Knowledge; strengthen STI infrastructure to support programmes in priority areas; and strengthen monitoring and evaluation in the S&T Sector.

The institutional framework to support and improve coordination and management of the S&T sector is also provided. Through this policy document, the key coordination and management institutions, including the Ministry in charge of Science, Technology and Innovation; the National Commission for Science, Technology and Innovation; the Kenya National Innovation Agency; and the National Research Fund, will work with all stakeholders in Government, private sector and academia to transform Kenya from a factor-driven economy into a knowledge-based economy.

To ensure effective implementation, the Government will establish a framework for coordination, monitoring and evaluation of the Policy. The Monitoring and Evaluation Framework will utilize strategic information obtained from the STI data collection systems. The S&T sector will develop and adopt a common set of indicators at both national and county levels to track performance of the sector. Further, the Government will establish mechanisms for effective communication and profiling of STI within the scientific community, policy makers, consumers of STI products and services and other STI actors.

The Ministry in charge of STI shall develop an Annual Presidential Report on The Status of STI in the Country.

It is envisaged that the policy will be reviewed at least every 5 years or as need arises.

CHAPTER 1: INTRODUCTION

Background

1. The history of Kenya's Science, Technology and Innovation (STI) Policy formulation can be traced back to the 1970 – 1974 National Development Plan which proposed the establishment of the National Council for Science and Technology (NCST). The subsequent Development Plan (1974 – 1978) mandated the NCST to ensure the application of results of scientific activities to the development of agriculture, industry and social welfare in the country. In 1977, the Science and Technology (S&T) Act (Cap 250) was enacted. The Act established NCST and assigned it the mandate to determine national scientific and technological priorities and advise the Government on national S&T Policy. Against this background, the Sessional Paper No. 5 of 1982 on Science and Technology for Development (GOK, 1982) was formulated. The paper highlighted the weak research capacity in industry and proposed establishment of a National Research Fund (NRF) that would receive exchequer funding to the tune of 1% of GDP.

2. In 2003, the government unveiled the Economic Recovery Strategy for Wealth and Employment Creation (ERSWEC, 2003 – 2007). On science and technology, the blueprint sought to bridge the gap between generation and storage of scientific knowledge and technology, and its adoption and application in productive activities. It further directed Ministries to develop and implement strategies that would enhance linkages between researchers/technology developers and producers. In addition, Ministries were required to develop strategies for capacity building in beneficiary organizations to empower them to make demands on service providers, thus making science and technology demand driven. Following the launch of Kenya Vision 2030 in 2008, the Government made significant changes to the country's science and technology sector. The enactment of the Science, Technology and Innovation Act, 2013 repealed the Science and Technology Act (CAP 250) of 1977. The Act established the National Commission for Science, Technology and Innovation (NACOSTI) as the successor to NCST, the Kenya National Innovation Agency (KENIA) and the National Research Fund (NRF). The Act provides a framework for a coordinated approach to facilitate the promotion and regulation of the progress of science, technology and innovation of the country. It further provides for priority setting in science, technology and innovation, and entrenchment into the national production system.

Science, Technology and Innovation in National Development

3. The creation and application of knowledge is vital to socio-economic growth, competitiveness and employment creation in a dynamic global arena characterized by shifts in knowledge production and wealth generation. STI is a key component of social integration, sustainable development and poverty eradication. STI is an essential tool for international co-operation, solidarity and globalization. STI is a key enabler of the Kenya Vision 2030 and is expected to drive the national development agenda by ensuring that all sectors of the economy have access to new technologies and adequate knowledge in order to increase productivity and efficiency.

4. The Kenya Vision 2030, aims at transforming the country into “a newly industrializing, globally competitive middle-income country, providing a high-quality of life to all its citizens” by the year 2030. The Vision is implemented through successive five-year Medium-Term Plans (MTPs) since 2008 with STI as a key foundation in the realization of the Vision goals and objectives. Currently the Government is implementing the Third MTP III (2018-2022).

5. Kenya Government is committed to the attainment of the Sustainable Development Goals (SDGs), the Africa Agenda 2063 and the targets of Science, Technology and Innovation Strategy for Africa (STISA), 2024. The STI Policy will support the implementation of these and other relevant international and regional development frameworks and commitments.

6. The Constitution of Kenya (2010) recognizes the role of science and indigenous technology in development of the nation and commits to promote Intellectual Property Rights (IPR). Further, the Constitution acknowledges academic freedom and freedom of scientific research as a right.

7. Thus, the State is required to promote all forms of national and cultural expression through literature, the arts, traditional celebrations, science, communication, information, mass media, publications, libraries and other cultural heritage;

8. By virtue of Article 2 (5), (6) of the Constitution, treaties or conventions ratified by Kenya form part of the law of Kenya. Accordingly, a number of conventions relating to STI which Kenya has ratified, form part of the legal and Institutional framework of the country.

Rationale for the STI Policy

Kenya’s Science and Technology Sector has grown substantially since independence and is key in transforming the economy. In an interconnected globalized world, many life-threatening challenges move rapidly from one region to another with serious ramifications on human health, relations and livelihoods. The COVID-19 Pandemic is perhaps one of the greatest challenge that globalisation has brought forth. Its effects have transcended beyond human health to negatively affecting socioeconomic, cultural and political settings. Learning from this, the S&T sector will be instrumental in anticipating and adequately responding to possible future pandemics that may occur in the country. Therefore, harnessing the full potential of this sector in a coherent and coordinated manner necessitates the formulation of a comprehensive STI policy framework.

9. This will facilitate regulation, coordination; promotion and provision of advisory services on STI to the national and county governments. Further, the STI Policy will guide the mobilization and allocation of resources to scientific research, infrastructural development and building technical capacities in STI.

Dimensions of the Policy

10. Policy priorities include:

- i) Legal and institutional framework;
- ii) Human resource development;
- iii) Education, training and research;
- iv) Funding for STI;
- v) Technology development, transfer and diffusion;
- vi) Infrastructure for science, technology and innovation;
- vii) Collaborations and partnerships in STI
- viii) Gender mainstreaming in STI; and
- ix) Performance Management.

The Policy Development Process

11. The preparation of the STI Policy was undertaken through a highly consultative and participatory approach. The process involved various stakeholders in the STI sector including the public sector, private sector, Non-Governmental Organizations (NGOs) and development partners.

CHAPTER 2: SITUATION ANALYSIS

12. The situation analysis is based on a comprehensive review of the key framework conditions and performance indicators that are necessary for an effective National Innovation System (NIS). The analysis has been informed by the results of STI surveys and other published reports.

Legal and Institutional Framework

13. The Constitution of Kenya (2010) provides the overarching legal framework upon which the development of STI is anchored. Article 10 of the Constitution recognizes the national values and principles of governance such as equity, inclusiveness and gender equality. Article 11 of the Constitution recognizes the role of science and technology in the development of the nation. Article 69 obligates the State to among other things protect and enhance intellectual property rights and indigenous knowledge of biodiversity and the genetic resources of the communities. Article 40 (5) obligates the State to support, promote and protect the intellectual property rights of the people of Kenya. The State is hence obligated to promote innovations and technology transfer.

14. In response to exclusion and marginalization experienced by some communities since independence, the Constitution provided for devolved governance to promote social and economic development and provision of proximate, easily accessible services throughout Kenya. The Fourth Schedule outlines the functions conferred on the 47 County Governments such as agriculture, health, transport and trade development and regulation among others. There is need to proactively engage County Governments in order to improve service delivery through application of STI.

15. The science and technology sector is regulated by the Science, Technology and Innovation Act, 2013. The Act provides the legal framework to facilitate the promotion, co-ordination and regulation of the progress of science, technology and innovation of the country; to assign priority to the development of STI and to entrench it into the national production system. The Act established three (3) institutions (NACOSTI, KENIA and NRF) to regulate, coordinate and support STI and envisages the provision of up to 2% of the GDP for funding research for advancement of STI in the country. Legal Notices Numbers 106, 107 and 108 of 2014 further provides for the operationalisation of sections of the Act.

16. Other laws that regulate the S&T sector include: The Industrial Property Act No.3 of 2001; The Trade Mark Act (CAP 506), Copyright Act, 2001; Seeds and Plant Varieties Act (CAP 326); Wildlife (Conservation and Management) Act, 2013; the Biosafety Act (CAP 321A); Kenya Agriculture and Livestock Research Act, 2013; Environment Management and Coordination Act, 2015; and the Kenya Plant Health Inspectorate Service Act, 2012.

17. The multiplicity of legislations in the S&T sector coupled with overlapping mandates and functions presents a challenge in coordination, compliance and enforcement.

18. The Ministry in charge of STI has overall policy responsibility on issues of science, technology and innovation in Kenya. It also coordinates the implementation of flagship programmes across all sector Ministries, Departments and Agencies (MDAs) with respect to STI. The key Government Institutions that support the development of STI are; NACOSTI, NRF and the KENIA. Further there are public and private institutions that carry out research and development in different fields of science. The public research institutions are domiciled in different ministries. The County Governments are important actors in the STI sector since study sites are domiciled in counties and are therefore the end users of research outputs and recommendations.

19. The existence of numerous regulatory frameworks in the S&T sector has negatively impacted on the STI governance system. In some cases County legislative frameworks conflict with the provisions of national research regulations and priorities.

Human Resource Development

20. The Economic Survey Report 2019 indicates that the proportion of female wage employees in Kenya was 33.88% in 2017 across all sectors. This shows a clear gender disparity in the labour market which is mostly pervasive in the STI related industries. For instance, in the professional, scientific and technical jobs, the number of male employees was 48,400 and females were 18,200. Further, in human health and social work jobs, the number of male employees was 66,800, while their female counterparts were 72,200.

21. The 2014 African Outlook Report shows that Kenya had 13,012 research personnel in 2010 which translated to 322 research personnel per million people in the population, which is low compared to established knowledge-driven economies. Higher Education Institutions (HEIs) have researchers with the highest level of education qualifications. In addition, the number of Full Time Equivalent (FTE) was 9,305 indicating that the researchers especially in the universities are not fully engaged in R&D.

22. According to UNESCO Institute for Statistics, 2015, the proportion of female researchers in sub-Saharan Africa is 30%, while in Kenya it stands at 26%. This shows low participation of women in research.

23. The number of R&D personnel in the country according to National Research and Development Survey Report, 2019 is 24,648 where 62% male were involved in Research compared to 38% of their female counterparts. This translates to less than 1% of the population involved in research. This is low by international standards. In addition, the available capacity is not fully utilized.

Education, Training and Research

24. Kenya has experienced rapid growth of the education sector since 2003. The introduction of Free Primary Education (FPE) and Free Day Secondary Education (FDSE) coupled with huge investment in infrastructure, human resources and ICT integration has increased access to pre-primary, primary and secondary education. In 2018 the Gross Enrolment Rate (GER) in primary schools stood at 104% and 70.3% in secondary schools.

25. The expansion of basic education and the on-going implementation of the Competence-based Curriculum (CBC) provides great opportunity for the mainstreaming of science and technology and integration of learning based on discovery and competence development. Implementation of the digital literacy programme provided laptops to Kenyan primary school-going children, trained teachers and developed digital curriculum, thereby integrating the use of digital technologies into the curriculum. By September 2019, 1,148,160 devices had been installed in 21,232 schools, or 97.7% of the target. However, performance in STEM related subjects remains poor in both primary and secondary schools. This is aggravated by the shortage of science laboratories, equipment and qualified teachers which are critical ingredients for enhancing performance in sciences and technology-oriented subjects.

26. Kenya has a fast-growing university, technical vocational education and training institutions that have boosted student enrolment in tertiary and higher learning institutions. The number of universities stood at 74 with a student enrolment of 513,182 (302,639 male and 210,543 female) in 2018. Similarly, the number of TVET institutions increased rapidly rising from 755 in 2014 to 2289 in 2018 with a student enrolment of 363,884 (205,142 male and 158,742 female). However, the rapid expansion of the sector has constrained available financial and human resources resulting in reduced focus on research. Other impeding factors include: insufficient qualified staff to teach STEM related programs, gender disparities, high costs associated with delivering STEM related courses, low funding for R&D and weak linkage with industry.

27. Similarly, enrolment of females in higher education is lower than males at all levels of training. The Kenya Economic Survey 2019 indicates that the proportion of female enrolment in both public and private universities was 41.8% in 2017/18. Specifically, participation in Science, Technology, Engineering and Mathematics (STEM) programmes shows a clear gender disparity ranging from 30% to 35%. Fewer women participate, and even fewer complete their studies.

Funding STI

28. A robust financial environment is critical for R&D. Financing of S&T sector is fragmented, institution based and inadequate. Various sub-sectors have unique financing structures that are entrenched in their respective legal and policy frameworks. These structures have established institutions that independently source for and manage

financial resources within their sub-sectors. The Government provides competitive research grants to individuals and institutions through the NRF. However, there is lack of a comprehensive and coordinated financing framework to support the S&T sector leading to inadequate mobilization and utilization of resources in the sector. There is no mechanism for tracking and documenting budgetary allocation for the S&T sector by the County governments. Significant gender disparities in funding for R&D exist as reflected in the limited number of female researchers and low participation in STEM programmes. Further, there are inadequate incentive mechanisms to support private sector investment in R&D.

29. National expenditure on R&D stood at 0.98% of GDP as at 2014 against the target of 2%. Expenditure by Universities on R&D is not clearly documented although it is expected to be 2% of their annual budgets. According to the 2014 African Innovation Outlook Report, external funding accounted for 47% of the national gross expenditure on R&D. This means that almost half of the research programmes are donor-funded. National Research and Development Survey undertaken in 2019 showed that National expenditure on R&D was at 0.77% of GDP.

Technology Development, Transfer and Diffusion

30. The Government has provided an enabling environment for establishment of large and multinational companies, Micro, Small & Medium Enterprises (MSMEs) and Start-up companies. However, they are not adequately linked to the existing incubation & commercialization, Science & Technology Parks and Special Economic Zones for adequate business support.

31. The Global Innovation Index 2019 Report ranks Kenya 77th out of 129 countries and among the top 10 in the lower middle-income countries. Kenya's production systems have not fully integrated innovation to enhance competitiveness. As a result, key sectors such as manufacturing have experienced slow growth making it difficult for them to compete effectively. Kenya's industrial structure displays insufficient linkages and synergies between the various sectors of the economy such as education, manufacturing, trade and ICT. Further, the structure fails to adequately integrate the MSMEs, where most innovations take place. In addition, most local firms have not been able to develop technological competencies to acquire and apply knowledge from foreign firms while most start-up companies close up before their maturity.

32. Technological learning within the business system is not formally structured and appropriately managed to ensure technology transfer. In addition, training activities are not inbuilt in the contracts with industry to facilitate deeper technological competencies and related managerial capabilities.

33. There are diverse efforts by the actors in the S&T sector supporting the creation of more effective products, processes, technologies and services that are acceptable by the market and society. These efforts include development of innovation hubs, business incubation centres, S&T parks and special economic zones for purposes of converting ideas, research, or prototypes into viable products and services. Technology incubation supports entrepreneurs and start-up technology enterprises in the development, assimilation, absorption and utilization of the requisite technology to accelerate their successful development. Commercialization is necessary step for business success of innovations from start-up ventures or public and private research efforts.

34. Operational linkages among the academia, industry and government are weak resulting in a poor enabling environment for growth of innovations and low rate of commercialization of research outputs. In addition, the operational structures and financial support to facilitate the necessary linkages among the key S&T actors are weak. There is limited awareness of the commercialization of innovations among the general population leading to the slow business and enterprise development. The infrastructure to support innovation, incubation and commercialization is not very well developed thereby hindering the growth of knowledge-based business start-ups.

35. Kenya has an existing IPR regime that grants Industrial Property Rights and promotes innovation for social and economic development. The Kenya Industrial Property Institute (KIPI) 2018 report indicates that only 31.25% resident patents were granted out of the total granted patents in the year. This shows that the level of uptake and commercialization of intellectually protected products and services is low partly owing to limited awareness of the existing legislation. Documentation and preservation of indigenous resources and traditional knowledge is inadequate and fragmented. The IPR regime does not adequately facilitate the verification and protection of indigenous knowledge and resources.

36. Kenya generates a lot of data through the R&D institutions. The UNESCO 2015 report indicates that Kenyan researchers generated 30.2 articles per million inhabitants, trailing Gabon and Cameroon with 80.1 and 30.9, respectively. The generation, storage and dissemination of STI data and information is not coordinated and interactive enough to inform policy decisions. There is lack of promotion centres at national and county levels to create interest and a culture of STI. Further, the country lacks a tracking system for the establishment of the status of STI indices to benchmark the national system of innovation for global competitiveness.

Infrastructure for Science, Technology and Innovation

37. Infrastructure is a key foundation upon which STI activities are operationalized. The Government has allocated resources for development of STI supporting infrastructure. However, the infrastructure in most public research institutions and universities is inadequate, a large proportion of which is unserviceable, and in some cases

does not consider aspects of gender equality and inclusion. There is also low awareness on the existence of high-end equipment within some of the R&D institutions. Accelerated development and improvements on this infrastructure in consideration for gender responsiveness and inclusiveness is critical to keep pace with the rapidly evolving S&T sector.

Advocacy and awareness in STI

38. The Science, Technology and Innovation Act, 2013 obligates NACOSTI to promote increased awareness, knowledge and information of research system. There exist different fora for advocacy and awareness for STI, which include the Annual Science Week, exhibitions and fairs, mentorship programme for promotion of STEM education among girls in secondary schools, and science and engineering congresses. There is limited engagement with the County Governments yet they have immense responsibilities in service delivery which requires them to adopt new knowledge and innovative strategies. The science culture among the Kenyan populace is low which is attributed to limited information on the role of STI in daily life. This is compounded by negative perceptions, stereotypes and attitudes that hamper gender equality and inclusion in STI education and careers. The existing advocacy and awareness programmes are not well structured and coordinated. In addition, the resources for advocacy and awareness programmes are limited.

Collaborations and Partnerships in Science, Technology and Innovation

39. Rapid development in science and technology has resulted in growth of collaborations and partnerships amongst different sectors of the national, regional and global economy. This has enhanced the flow and sharing of knowledge, infrastructure and technologies which has significantly reduced the scientific and digital divide. Kenya's contribution in regional and international scientific and technological development programmes has enhanced industrial development, global competitiveness and employment opportunities. However, without a clear engagement framework to coordinate collaborations and partnerships involving multiple actors in the STI sector, the country has not achieved optimal benefits from the existing collaborations and partnerships. Other impediments have arisen from lack of adequate and accurate data on the existing partnerships and collaborations, and proper documentation on programmes implemented.

Gender Mainstreaming in STI

40. Despite a progressive Constitution that promotes gender equality and women's empowerment, gender inequality remains a key issue of concern in Kenya. The patriarchal social order supported by statutory, religious and customary laws and practices; and the administrative and procedural mechanisms for accessing rights have continued to hamper the goal of attaining gender equality and women's empowerment.

41. Studies have shown that in Kenya, there exist significant gender disparities in STI programs in both education and industrial sectors. For instance, in 2017, out of the 2,124 registered engineers in the country, only 170 were women translating to a paltry 8% of the total. There are many barriers which hinder women and girls' participation in STEM and STI programmes. These include social and cultural factors that are not empirically supported since they are advanced through myths, beliefs, gender stereotypes, attitudes and perceptions that women and girls lack interest and capability to pursue education and careers in STEM related disciplines.

42. The labour market lacks systems to promote gender equality in entry, mobility and retention of scientists and technologists in employment.

Performance Management

43. Monitoring and Evaluation (M&E) is critical for tracking the progress and achievement of the objectives of the S&T sector. M&E assists in developing measurable indicators to determine the level of achievement of set targets. The M&E process links programme outcomes to long term impacts of the policy and measures its contribution to the national development agenda. Kenya established the National Integrated Monitoring and Evaluation System (NIMES) to track the implementation of policies, programmes and projects. However, data on the status of STI have not been adequately covered.

44. Various agencies collect and analyse STI data relevant to their specific mandates for purposes of M&E although the knowledge and data management system is not well coordinated. It lacks data harmonization across institutions, continuous updating and gender segregation.

CHAPTER 3: SCIENCE, TECHNOLOGY AND INNOVATION POLICY FRAMEWORK

Vision

45. Accelerated transition to a knowledge-based economy

Mission

46. To mainstream the application of science, technology and innovation in all sectors through generation, acquisition, dissemination and utilisation of available capacities in order to achieve the objectives of the Kenya Vision 2030

Goal

47. To facilitate transformation of the economy from a factor-based to a knowledge-based economy

Philosophy

48. Science, Technology and Innovation is premised on the philosophy "*research for socioeconomic transformation, global competitiveness and sustainable development*"

Guiding Principles

49. Effective implementation of the STI Policy will be guided by the following principles:
- i. Relevance to the country's Vision 2030 and the Constitution 2010;
 - ii. Quality, novelty and originality;
 - iii. Cost-effectiveness for desired results;
 - iv. Multi-disciplinary and cross-sectoral approach to problem-solving;
 - v. Collaboration and partnership;
 - vi. Environmental conservation;
 - vii. Empowerment and participation of women, youth and persons with disabilities;
 - viii. Equity and inclusiveness;
 - ix. Evidence based; and
 - x. Good governance.

Policy Objectives

50. The objectives of this policy are to:
- i. Strengthen legal framework and governance of STI;
 - ii. Enhance the quality and capacity of the human resource and talent management;

- iii. Re-align education and training programmes to national goals and regional/counties and industry needs;
- iv. Develop mechanisms for sustainable financial resource mobilization and investment in STI
- v. Enhance technology development, diffusion, transfer, and commercialisation;
- vi. Strengthen the STI infrastructure;
- vii. Enhance collaborations and Partnerships in STI;
- viii. Promote gender mainstreaming in STI
- ix. Provide mechanisms for promoting, monitoring and evaluation of STI programmes;

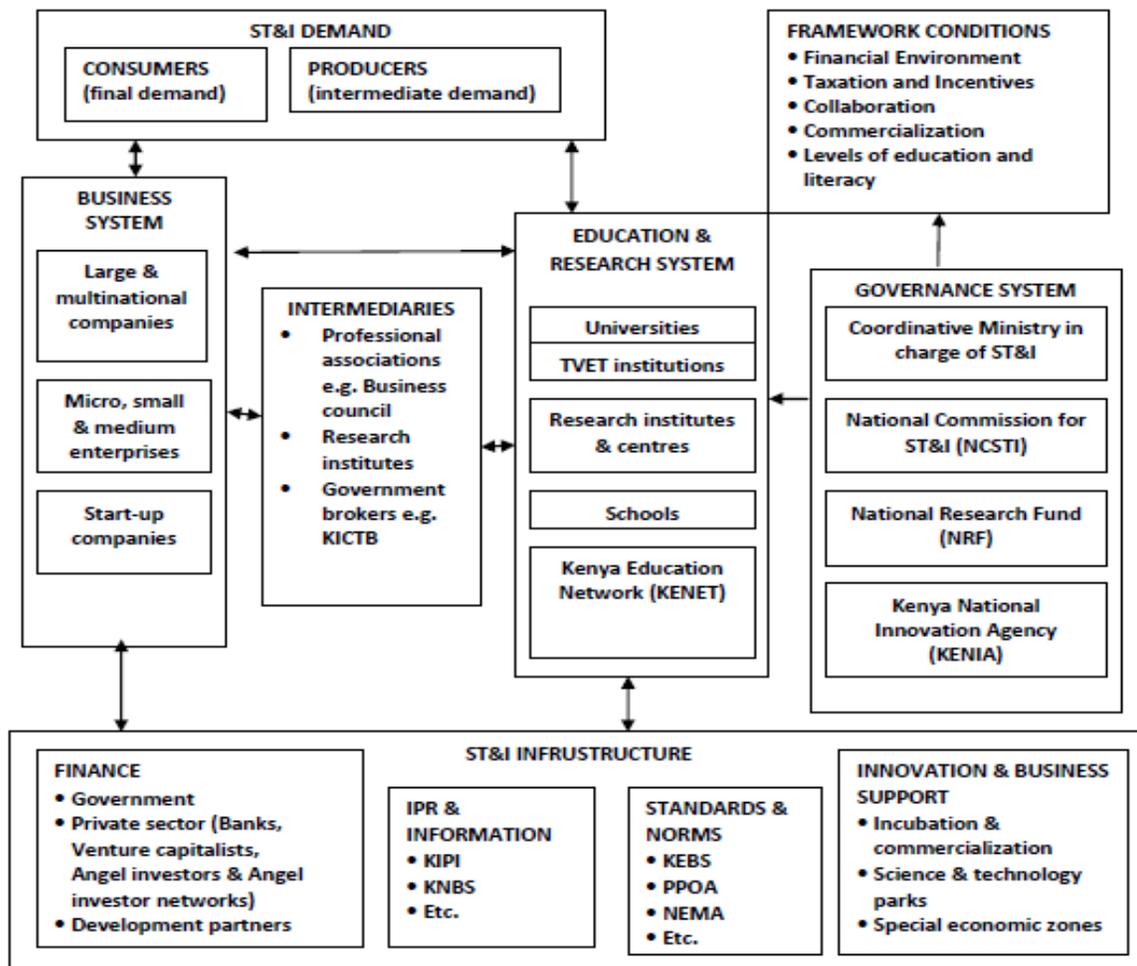


Figure 1: Major Components of the Kenya National Innovation System

CHAPTER 4: POLICY STATEMENTS AND STRATEGIES

51. The policy statements and strategies are geared towards harnessing the opportunities within the S&T sector and addressing challenges affecting the sector to maximize its contribution to socioeconomic growth and development. The policy prioritises the following strategic issues:

- i) Legal and institutional framework;
- ii) Human resource development;
- iii) Education, training and research;
- iv) Funding STI;
- v) Technology development, transfer and diffusion;
- vi) Infrastructure for science technology and innovation;
- vii) Collaborations and partnerships in Science and Technology
- viii) Gender mainstreaming in STI; and
- ix) Performance management framework.

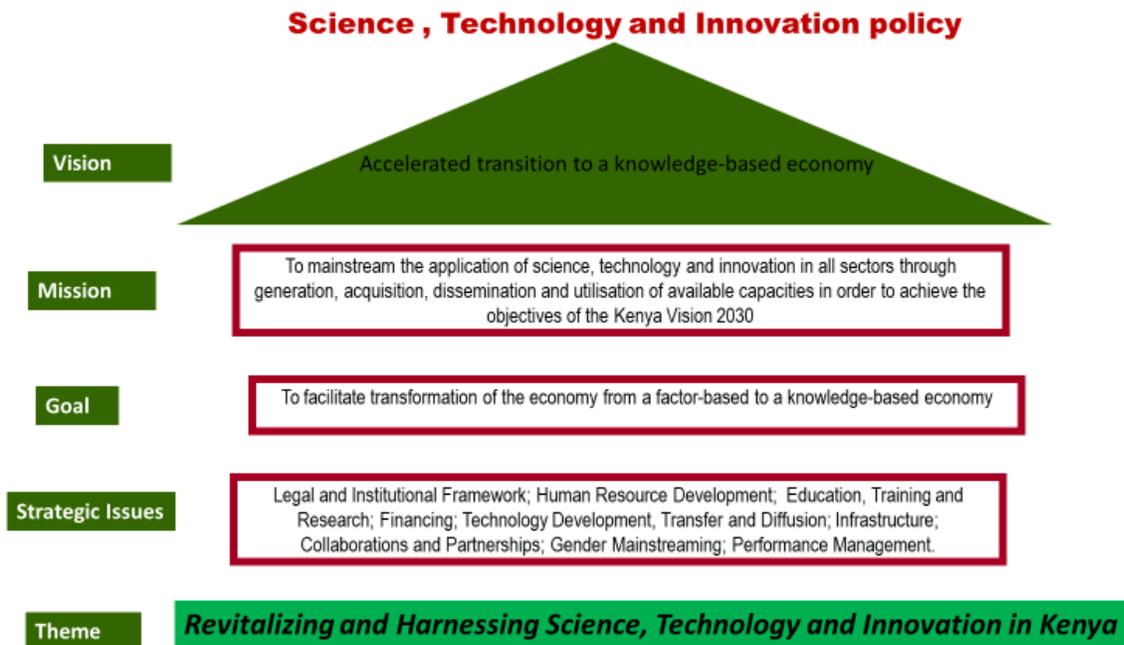


Figure 2: Framework for the Science, Technology and Innovation Policy

Legal and Institutional Framework

52. The Science and Technology sector has multiplicity of legislations with overlapping provisions. This has resulted in weak coordination and regulation which negatively affects performance of the institutions within the sector.

53. To address these issues the Government will adopt the following policy:

Strengthen legal framework and governance of STI.

54. To implement the above policy, the Government will employ the following strategies:

- i) Review and harmonize the existing legal and regulatory framework;
- ii) Strengthen governance framework for effective integration of STI in all sectors of the economy;
- iii) Promote effective coordination, gender equity, inclusiveness, and partnership in STI.
- iv) Develop an implementation framework for Programmes and Projects
- v) Strengthen mechanisms for implementation of international obligations in STI

Human Resource Development

55. The level of technically qualified personnel in the S&T sector is low by international standards, with significant gender disparities and exclusion of certain categories of the population in most fields of STI. The supply of human resource for the S&T sector in new and emerging technologies is inadequate. In addition, the available capacity is not fully utilized.

56. To address the above Human Resource gaps, the Government will adopt the following policy:

Enhance the quality and capacity of the human resource and talent management

57. To implement the above policy the Government will employ the following strategies:

- i) Establish and regularly update an STI skills inventory;
- ii) Enhance gender parity and inclusion in STI programmes;
- iii) Provide mechanisms to attract and retain human resource in STI;
- iv) Promote and strengthen research programmes and sector working groups in prioritized STI areas;

Education, Training and Research

58. The performance in STEM related subjects is relatively poor. This can partially be attributed to inadequate qualified staff, shortage of laboratories and equipment, high costs of delivering STEM related courses, low funding for R&D and weak linkage to industry. This is compounded by significant gender disparities in both staffing, student enrolment and completion. This has resulted in low research outputs from the universities and research institutions.

59. To address the issues the Government will adopt the following policy:

Re-align education and training programmes to national goals and regional/counties and industry needs;

60. In order to implement this policy, the Government will adopt the following strategies;

- i) Provide modern infrastructure and equipment in education and research institutions;
- ii) Adopt a continuous review and implementation of the education curriculum to respond to the needs of the S&T sector;
- iii) Establish centres of excellence that promote science, research and development, innovation, commercialization, knowledge sharing, and creativity;
- iv) Establish science centres including museums to inculcate STI culture
- v) Develop mechanisms for identifying, tapping and nurturing talent in STI sector;
- vi) Develop programmes with industry to strengthen technological capabilities through partnership and linkages with institutions of higher learning and research institutions;
- vii) Develop a mechanism for recognizing and rewarding achievement in STI; and
- viii) Promote gender equality, cultivate and sustain interest in STEM at all levels of education.

Funding Science, Technology and Innovation

61. The Science and Technology sector is inadequately funded and does not have a clear guiding framework for coordination of sector specific funding. This has resulted in weak coordination of resource mobilization efforts among the STI actors. It has further contributed to gender disparities in STI programmes as reflected in the low number of female researchers in certain fields. The participation of private sector in funding of R&D is low due to limited incentive mechanisms.

62. To address these challenges the Government will adopt the following policy:

Develop mechanisms for sustainable financial resource mobilization and investment in STI.

63. To implement the above policy the Government will employ the following strategies:

- i) Develop a framework for resource mobilization and utilization for STI;
- ii) Mobilise 2% of GDP annually to the S&T sector;
- iii) Enhance institutional, national, regional and international collaborations and partnerships to increase investments in STI;
- iv) Strengthen the capacity of the NRF to mobilize funds for research;
- v) Develop guidelines and sensitize County Governments to prioritize S&T in resource allocation;
- vi) Strengthen gender equality and inclusiveness in funding for STI programmes
- vii) Develop an incentive framework to attract private sector investment in R&D; and
- viii) Harmonize policies, planning and budgeting of the S&T sector.

Technology Development, Transfer, Diffusion and Commercialization

64. There is limited awareness and appreciation of Intellectual Property Rights among practitioners, stakeholders and policy makers. In addition, the existing IPR regime is not flexible enough to accommodate the ever-emerging issues in STI. The level of uptake and commercialization of intellectually protected products and services is also low.

65. Technological learning within the business system is not formally structured and appropriately managed to ensure technological capability building and appropriate technology transfer.

66. There is limited documentation and preservation of indigenous resources and traditional knowledge. The existing IPR regime does not adequately facilitate the verification and protection of indigenous knowledge and resources.

67. To address the constrains to technology development, transfer, diffusion and commercialisation the Government will adopt the following policies:

- i) Establish, in collaboration with County Governments innovation incubation centres and S&T parks to promote entrepreneurial development and talent management;
- ii) Strengthen the Intellectual Property Rights Regime;

- iii) Promote development, transfer and diffusion of ideas and knowledge into products and processes; and
- iv) Provide an enabling environment for sustainable utilization of Indigenous Resources and Traditional Knowledge.

68. In order to implement the above policies, the Government will adopt the following strategies:

- i) Develop and implement a National Intellectual Property Policy;
- ii) Review the Intellectual Property Rights regime to facilitate the verification, acquisition and protection of indigenous resources and knowledge;
- iii) Create awareness on the importance of Intellectual Property Rights;
- iv) Strengthen industry-academia linkages to encourage commercialization, venture capitalists, and spin-offs;
- v) Promote the establishment of technology transfer, and industrial liaison offices;
- vi) Strengthen the capacity of NACOSTI, NRF and KENIA to facilitate technology development, transfer, diffusion and commercialization both at the National and county government level;
- vii) Support annual conferences, exhibitions and expert dialogues on the state of STI;
- viii) Facilitate research institutions to develop institutional IPR policies;
- ix) Develop quality standards and enhance accreditation of testing and calibration laboratories;
- x) Promote the establishment of business incubators and science & technology parks;
- xi) Establish an innovation database on technology acquisition and transfer;
- xii) Document the extensive indigenous resources and traditional knowledge;
- xiii) Promote sustainable utilization and conservation of indigenous resources and traditional knowledge;
- xiv) Promote local inventions and innovations; and
- xv) Provide support for increased technology transfer to MSMEs.

Infrastructure for Science, Technology and Innovation

69. Currently the country is faced with inadequate STI facilities, slow modernization, poor country wide distribution networks and accessibility. There is inadequate investment in infrastructure for STI. Some infrastructure lack compliance with the needs and safety of certain groups thus promoting inequalities and marginalization. Further, the use of ICT is limited especially in rural areas due to inadequate network connectivity.

70. To address the infrastructure deficit, the Government will adopt the following policy:

Strengthen STI infrastructure to support Programmes in priority areas

71. To implement the above policy the Government will employ the following strategies:

- i) Establish the status of STI infrastructure in the identified priority areas;
- ii) Provide adequate STI infrastructure in education, training and research institutions;
- iii) Establish mechanisms for sharing R&D infrastructure amongst institutions; and
- iv) Promote infrastructural compliance with the needs of all groups to address gender inequalities and marginalization.

Collaborations and Partnerships in Science, Technology and Innovation

72. Kenya has made significant advances in forging strategic alliances with international and regional partners, thus placing the country as a major player in the global arena. Accordingly, enhancing international cooperation in Science and Technology will go a long way in multiplying Kenya's stakes in the global market, taking cognizance of the universality and dynamism of scientific and technological knowledge.

73. The government has made tremendous efforts to strengthen partnerships with regional and international agencies in the advancement of STI. However, there is need to exploit the massive and untapped potential of the Kenyans abroad.

74. To enhance collaborations and partnerships in STI, the Government will adopt the following policies;

- i) Establish strategic collaborations and partnerships at national, regional and international levels;
- ii) Strengthen existing collaborations and partnerships at national, regional and international levels;
- iii) Promote collaborations and partnerships at national, regional and international agencies in advancement of STI;

- iv) In order to implement the above policies, the Government will adopt the following strategies;
 - a) Promote participation in STI networks at national, regional and international levels;
 - b) Facilitate acquisition and development of new and emerging technologies;
 - c) Establish an STI forum that is inclusive of the Kenya Diaspora and descendants;
 - d) Promote the participation for the Kenyan diaspora in national development
 - e) support public agencies that are already engaged in international and regional treaties and cooperative agreements; and
 - f) Promote the establishment of multidisciplinary and multi-institutional teams of experts for collaborative research and development.

Gender Mainstreaming in STI

75. Gender inequality in the education and labour markets persist despite the progressive constitutional provisions, policy, legislative and institutional frameworks.

76. There exist social and cultural barriers to women and girls' participation in STEM education and careers. Though not empirically supported, myths, beliefs, gender stereotypes, attitudes and perceptions have contributed to the low number of women and girls pursuing education and careers in STEM related disciplines.

77. To address these challenges the Government will adopt the following policy:

Promote gender equality in all STI related programmes and activities, and in decision making

78. To implement this policy, the Government will adopt the following strategies:

- i) Ensure gender equality in participation and distribution of opportunities and benefits of STI;
- ii) Design and initiate affirmative action initiatives to ensure gender equality and inclusiveness in STI related programmes, activities, and in decision making and planning;
- iii) Design and implement sensitisation of the general public and key stakeholders (policy makers, research, civil society, local communities, academia, faith-based organisations, NGOs, students etc.) on the relevance of gender equality in STI;
- iv) incentivise STI education and training for the underrepresented gender at all levels of schooling (primary, secondary and tertiary), including public and private sector institutions in order to facilitate the equal participation in STI;
- v) Review the educational curricula at all levels to build capacity for the achievement of gender equality and to comply with the constitutional provisions and other legislative requirements, regional and international standards;

- vi) Facilitate gender responsive entrepreneurship training to enhance the ability and capacity to innovate, utilise, and commercialise STI;
- vii) Promote mentorship programmes in schools and sensitize households to encourage girls to take up STEM related careers;
- viii) Improve collection, analysis, storage and dissemination of disaggregated data by age and gender in STI; and
- ix) Ensure gender equality in budgetary allocations and distribution of other resources for STI programmes at institutional, county and national government levels.

Performance Management Framework

79. Kenya lacks an integrated data and information management system for collecting, collating, storing and sharing STI data to inform policy. This has led to inadequate STI data for inclusion in the national statistics system. Consequently, the contribution and impact of the STI sector to the national economy is not quantified.

- i) Develop and implement an effective performance management framework;
- ii) Support and encourage the development of STI indicators and evaluation mechanisms; and
- iii) Establish a framework for promoting ranking of STI institutions and universities as a measure of global competitiveness and responsiveness to national development agenda.

80. To address these challenges the Government will adopt the following policy:

Strengthen Monitoring and Evaluation in the STI Sector

81. To implement this policy, the Government will adopt the following strategies:

- i) Strengthen the human resource capacity of the S&T actors to undertake M&E;
- ii) Develop and implement monitoring and evaluation tools and STI performance indicators that are integrated in the annual plans and development planning processes at institutional, county and national government levels;
- iii) Enhance the collection, collation and analysis of sex disaggregated data to inform policies, planning and decision-making;
- iv) Institutionalize STI surveys in the sector;
- v) Develop and implement an efficient web-based monitoring and evaluation system.
- vi) Develop and implement a globally benchmarked performance management framework; and
- vii) Establish a framework for ranking of STI institutions and universities as a measure of contribution to national development and global competitiveness.

CHAPTER 5: STI POLICY IMPLEMENTATION FRAMEWORK

82. The Policy implementation framework consists of the legal, institutional and functional arrangements necessary to ensure effective implementation of the STI policy. The framework constitutes the institutions and the coordination mechanisms, monitoring and evaluation, communication and publicity mechanism and policy review.

83. The Government will put in place mechanisms to facilitate the promotion, coordination, and regulation of STI to entrench it into national and county production systems. To harmonize the legal, institutional and regulatory framework for development and utilization of STI, the Government will develop and review requisite legislation to support the sector. The Government will promote research, science, technology and innovation through grants, awards, tax schemes and other mechanisms. Further, to promote, coordinate and regulate the S&T sector the Government will strengthen NACOSTI, KENIA and NRF.

Institutional Framework

84. The successful implementation of this Policy will be governed by the development of an Implementation Framework and Plan. The Framework and Plan will outline specific programmes, activities, timelines, responsible actors and key performance indicators.

85. MDAs, County Governments and institutions of higher learning will align their institutional work plans with the implementation Plan, and the private sector will be encouraged to do the same.

86. The Ministry in charge of Science, Technology and Research will be responsible for policy, planning and coordination for the sector. It will coordinate the implementation of flagship programmes across all sector Ministries, Departments and Agencies with respect to science, technology, innovation and Research.

87. The National Commission for Science, Technology and Innovation (NACOSTI) shall regulate, assure quality, promote, coordinate and advise Government on matters of science, technology, innovation and Research in the STI sector.

88. The National Commission for Science, Technology and Innovation (NACOSTI) shall establish Advisory Science, Technology, Innovation and Research Committees to give advisory on different thematic multidisciplinary areas.

89. The National Commission for Science, Technology and Innovation (NACOSTI) shall develop, in consultation with stakeholders, the national priorities and implementation framework, in scientific, technological, innovation and Research activities in Kenya in relation to the economic and social policies of the Government, and the country's international commitments. The National Steering Committee, and a delivery secretariat established by the Cabinet Secretary responsible for Science, Technology and Research

will oversee and coordinate the implementation of the National Priorities in Science, Technology, Innovation and Research (STIR), respectively.

90. The National Commission for Science, Technology and Innovation (NACOSTI) shall ensure co-ordination, synergies and co-operation between the various agencies and partners involved in science, technology and innovation by establishing and coordinating a Science, Technology, Innovation and Research Network (STIRN) which shall pursue its objectives through thematic programmes focused on National Development agenda and research priority areas.

91. The Kenya National Innovation Agency (KENIA) will develop and manage the National innovation systems. This will include; promotion of innovations, facilitation of technology development and knowledge transfer, adaptation and diffusion through public-private partnerships.

92. The National Research Fund (NRF) will mobilise resources to facilitate research for the advancement of science, technology and innovation in line with national priority areas.

93. The academic and research institutions will develop the necessary science and technology capacities and research competence for effective implementation of this policy. They will further generate, curate and disseminate new knowledge and technologies to inform product development.

94. The private sector will play a key role in the implementation of this policy. This will include establishment of public private partnerships and venture capital with actors in the S&T sector.

95. The Government, both national and county, acting on the recommendation of NACOSTI, will designate Centres of Excellence (COEs) within the S&T sector on identified national priority areas.

Monitoring an Evaluation

96. The Government will establish a mechanism for monitoring and evaluation of the STI policy implementation. The M&E Framework will utilize strategic information obtained from the STI data collection systems to make decisions on how to improve use of science, technology and innovation for national development in all sectors.

97. The STI sector will develop and adopt a common set of STI indicators benchmarked with global indicators, at both the national and county levels to track performance. NACOSTI in consultation with the key agencies in the innovation system and other partners, will coordinate the development of STI indicators, and a framework for assessing Science, Technology and Innovation benchmarked with global best practice, and will provide an annual report on the status of STI in the country based on the approved STI indicators.

Communication and Publicity

98. The Government will establish mechanisms for effective communication and profiling of STI within the scientific community, policy makers, consumers of STI products and services and other STI actors.

99. The Ministry in charge of STI shall develop an Annual Presidential Report on The Status of STI in the Country.

Policy Review

100. This policy is envisaged to span a period of ten (10) years and will be reviewed after five (5) years or as the need may arise.

Implementation Matrix/Actions

101. The Ministry, responsible for Science, Technology and Innovation will continue to develop and drive STI-related policies and legislative programmes to support the STI Policy and align these activities with the National Development Plan. NACOSTI, KENIA and NRF will spearhead these activities as per their mandate collaborating with the other MDAs, academia, civil society and private sector to ensure the successful implementation of the Policy within/among the broad, multi-sectoral innovation system. The STI Policy will be implemented over 10 years. The Policy's Implementation Plan (below) details the activities for the first 5 years.

Table 1: Implementation Actions 2020-2024

Actions	'20	21	22	23	24	Key Players
POLICY OBJECTIVES						
Strengthen legal framework and governance of STI						Ministry Responsible for STI, NACOSTI, KENIA, NRF
Enhance the quality and capacity of the human resource and talent management						Ministry Responsible for STI, NACOSTI, KENIA, NRF, Academic Institutions
Re-align education and training programmes to national goals and regional/counties and industry need						Ministry Responsible for STI, Academic Institutions, Research Institutions, CUE, KENET
Develop mechanisms for sustainable financial resource mobilization and investment in STI						Ministry Responsible for STI, NRF, KENIA, NACOSTI
Enhance technology development, diffusion, transfer, and commercialization						Ministry Responsible for STI, KENIA , NRF, National IP offices, Universities and Research institutions
Promote gender mainstreaming in STI						Ministry Responsible for STI, NACOSTI , KENIA, NRF, KNATCOM, Training Institutions
Strengthen the STI infrastructure						Ministry Responsible for STI, NRF, KENIA, NACOSTI
Enhance collaborations and Partnerships in STI						Ministry Responsible for STI, NRF, KENIA, NACOSTI, State Law Office
Provide mechanisms for promoting, monitoring and evaluation of STI programmes						Ministry Responsible for STI, NRF, KENIA, NACOSTI

Actions	'20	21	22	23	24	Key Players
COMMUNICATION AND PUBLICITY						
Widespread dissemination and adoption of the National Policy, particularly among stakeholders central to its successful implementation						
Develop a policy communication strategy						Ministry Responsible for STI, NRF, KENIA, NACOSTI
Sensitization workshops with key stakeholders						Ministry Responsible for STI, NRF, KENIA, NACOSTI
Capacity building on implementation of the policy						Ministry Responsible for STI, NRF, KENIA, NACOSTI, Training, Research Institutions, National IP offices
LEGISLATIVE, REGULATORY AND INSTITUTIONAL FRAMEWORK						
All acts and regulations and policies governing STI institutions.						
Review the legislative, regulatory and institutional framework governing the STI sector						Ministry Responsible for STI, NACOSTI, NRF
Develop agenda to amend, establish and rationalize legislation required for successful implementation of the National STI Policy						Ministry Responsible for STI, NRF, KENIA, NACOSTI, Training, Research Institutions, National IP offices
Establish the National Steering Committee for the National Priorities in STI						Ministry Responsible for STI, NRF, KENIA, NACOSTI , Training, Research Institutions, National IP offices
Establish the Advisory Research Committees						Ministry Responsible for STI, NRF, KENIA, NACOSTI , Training, Research Institutions, National IP offices
Establish the STI&R Network						Ministry Responsible for STI, NRF, KENIA, NACOSTI , Training, Research Institutions, National IP offices
MAPPING						
Situational analysis of the national innovation system						
Establish and operationalize a multi-sectoral taskforce to map the national innovation system						Ministry Responsible for STI, NRF, KENIA, NACOSTI
Establish an STI database and information sharing mechanisms for decision making processes						Ministry Responsible for STI, NRF, KENIA, NACOSTI

Actions	'20	21	22	23	24	Key Players
NATIONAL STI STRATEGY						
Develop a national STI strategy						
Establish a working group to develop a National STI strategy						Ministry Responsible for STI , NRF, KENIA, NACOSTI
Sensitize stakeholders on the National STI strategy						Ministry Responsible for STI , NRF, KENIA, NACOSTI
Align the institutional strategic and operational plans with the National STI strategy						Ministry Responsible for STI , NRF, KENIA, NACOSTI, National IP Offices, Research Institutions, Regulatory Institutions, Training Institutions
MONITORING AND EVALUATION						
Develop a monitoring and evaluation framework						
Develop the National STI Indicators						Ministry Responsible for STI, NRF, KENIA, NACOSTI , National IP Offices, Research Institutions, Regulatory Institutions,
Sensitize stakeholders on the National STI Indicators						Ministry Responsible for STI, NRF, KENIA, NACOSTI , National IP Offices, Research Institutions, Regulatory Institutions, Training Institutions
Undertake a National R&D survey						Ministry Responsible for STI, NRF , KENIA, NACOSTI, KNBS
Undertake a National Innovation survey						Ministry Responsible for STI, NRF, KENIA , NACOSTI, KNBS
Launch the National surveys reports						Ministry Responsible for STI , NACOSTI, NRF, KENIA, Universities and Research Institutions
Disseminate the findings of the National surveys						Ministry Responsible for STI , NACOSTI, NRF, KENIA, Universities and Research Institutions

**Lead Institution shown in bold.*