The KENYA INSTITUTE for PUBLIC POLICY RESEARCH and ANALYSIS

Science, Technology, and Innovation in Enhancing Delivery of the Big Four Development Agenda

Proceedings of the 4th KIPPRA Annual Regional Conference Held from 23rd to 25th June 2021

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KIPPRA in Brief

The Kenya Institute for Public Policy Research and Analysis (KIPPRA) is an autonomous Institute whose primary mission is to conduct public policy research leading to policy advice. KIPPRA's mission is to produce consistently high-quality analysis of key issues of public policy and to contribute to the achievement of national long-term development objectives by positively influencing the decision-making process. These goals are met through effective dissemination of recommendations resulting from analysis and by training policy analysts in the public sector. KIPPRA therefore produces a body of well researched and documented information on public policy, and in the process assists in formulating long-term strategic perspectives. KIPPRA serves as a centralized source from which the Government and the private sector may obtain information and advice on public policy issues.

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4th KIPPRA Annual Regional Conference on "Science, Technology, and Innovation in Enhancing Delivery of the Big Four Development Agenda" Held From 23rd to 25th June 2021

CONFERENCE COMMUNIQUÉ

Preamble

The KIPPRA Annual Regional Conference (KARC) was successfully held from 23rd to 25th June 2021 at the Bomas of Kenya, with the theme: ***"Science, Technology, and Innovation (ST&I) in Enhancing Delivery of the 'Big Four' Development Agenda"***.

We express our gratitude and appreciation to all the partners who supported KIPPRA in organizing a successful conference. We acknowledge the importance of intensifying application of ST&I to raise productivity and efficiency levels across the social, economic, and political pillars as envisioned in the Kenya Vision 2030. The Constitution of Kenya 2010 explicitly places a premium on development and management of a knowledge-based economy.

The conference covered a wide spectrum of policy issues, including: Status of ST&I in Kenya; Policy, institutional and legislative framework; Development of human capital; Building a strong innovation system; ST&I infrastructure; Building resilience through ST&I; and Cross-cutting issues including gender, youth and PWDs.

This Communique brings out the key messages in harnessing ST&I for the achievement of the "Big Four" agenda, and global and regional normative frameworks, including the East African Community Vision 2050 and the African Union Agenda 2063 that calls for advancement in ST&I.

The conference resolutions provide an opportunity to researchers, policy makers, and actors in both public and private sectors to continue the dialogue in bridging the identified gaps to drive science, technology, and innovation for sustainable development.

Conference Objectives and Expected Outcomes

The broad objective of the conference was to provide a forum for policy makers, implementers, data producers and data users to discuss the use of ST&I in enhancing delivery of the 'Big Four' development agenda. Specifically, the objectives of the conference were to: examine the human resource development relevant for ST&I in Kenya; assess the infrastructure and related policies to support ST&I in Kenya; evaluate the innovation system in Kenya; investigate the institutional system and economic incentives to promote ST&I in Kenya, and determine the role of ST&I in building resilience in economic crises in Kenya.

The following were the expected outcomes from the conference:

1. Enhanced knowledge sharing on the status of ST&I and future areas of action;
2. Lessons learnt from good practices across the National and County Governments and at regional and global level;
3. Strengthened networking and partnerships with relevant stakeholders; and
4. Communique on harnessing ST&I in the achievement of the "Big Four" agenda and global commitments.

Participants

The conference was attended on daily basis by over 400 participants. The participants were drawn from key stakeholders, including Government ministries, local and international universities, state corporations, Non-Governmental Organizations (NGOs), embassies, research institutions, county governments, civil society, private sector, banking sector insurance companies, and the public.

CONFERENCE THEMES

Theme 1: Status of ST&I in Kenya

Scientific research generates new ideas that builds knowledge on development of new products and services. These ideas drive innovation, which contributes positively to economic activity through creation of new markets, diversification of goods and services, creation of job opportunities, and advancing methods of production. Kenya is a leading technology and innovation hub in Africa; it has witnessed investment in large-scale telecommunications infrastructure that supports efficient and affordable info-communications services.

Regarding the status of ST&I in Kenya, we note that:

1. There is need to increase uptake of Science, Technology, Engineering and Mathematics (STEM) courses. This can be achieved through provision of career guidance and mentorship to students in early years of learning, training of more personnel on STEM courses, and re-tooling to secure and advance the skills. This helps to build a strong skills base necessary to steer a knowledge-based economy.
2. There are several institutions carrying out ST&I activities. Development of a framework to track spending in ST&I activities is crucial to ensure the funding for ST&I meets the provisions of the STI Act 2013 (Rev. 2014) section 32(2)(a). Further, the Government could consider enhancing budgetary allocation for seed capital to support Research and Development (R&D).
3. Fintech has placed Kenya among the largest financial technology (fintech) ecosystems in Africa and in the world. To foster growth of the fintech ecosystem, there is need to strengthen the policy and regulatory framework in providing a conducive environment that supports emerging fintechs. In addition, the Government could encourage start-ups in the fintech ecosystem by offering tax incentives and helping secure funding for fintech innovations among micro, small, and medium enterprises (MSMEs).
4. E-commerce has the potential to reduce business costs, enhance business visibility and facilitate access to wider markets. To realize more gains from the platform, there is need

to strengthen the Internet infrastructure across the counties as a priority. In addition, the private sector could take lead in creating digital solutions to scale up new business models, develop new ways of delivering services, and increase the competitiveness of local markets.

Action: *The National Treasury; Ministry of ICT, Innovation and Youth; Central Bank of Kenya; National Research Fund; Parliament; Communication Authority of Kenya; and Kenya Bankers Association*

Theme 2: Policy, Institutional and Legislative Framework

The important role played by ST&I in achieving the development goals for world economies is widely acknowledged. In Kenya, the Vision 2030 has identified ST&I as a foundation for economic development. The ST&I Act of 2013 is the overarching legal framework. The ST&I sector is regulated under various regulatory frameworks, which have established various institutions mandated to carry out the relevant functions.

In strengthening policy, institutional and legislative framework in Kenya we note that:

5. Fast-tracking the enactment of the ST&I policy will create ST&I capacities that are appropriate to the needs, priorities, and resources of the country, and nurture a local science, technology and innovation culture.
6. Having an appropriate policy and legislative framework will establish and strengthen national and regional innovation systems. It will also enable commercialization of affordable technologies through the support of innovation hubs, incubation centres in universities, and technology transfer centres.
7. Having an appropriate policy, institutional and legislative framework will facilitate technical and managerial skilling up, modernization of worksites and provision of modern machinery and equipment to the MSEs sector.
8. Enhanced coordination and mainstreaming of ST&I activities serves to address the fragmented investments in ST&I and creating links between stakeholders for knowledge sharing, technology transfer, testing, certification, and quality improvements.
9. Innovation and use of technology are driven by business and private investors. Investments in R&D are high risk and investors need government guarantee as a leverage to inject their funds in ST&I development and commercialization of innovations. Therefore, it is incumbent upon the Government to provide fiscal and policy incentives to attract private sector investments in R&D and adopt technology use.

Action: *NACOSTI; Ministry of ICT, Innovation and Youth; Kenya National Innovation Agency; County Governments; private sector, and non-state actors*

Theme 3: Development of Human Capital

Education and research are key determinants of the ability to create a knowledge-based economy. The knowledge-intensive nature of science and technology requires highly qualified and skilled human

resources. Over the years, the number of arts and social science-based courses offered at the tertiary level has grown while courses in Science, Technology, Engineering, and Mathematics (STEM) have not. At the secondary and primary school levels, it is envisioned that the Competency-Based Curriculum will play a role in fostering creativity and interest in science and mathematics.

To enhance development of human capital in Kenya, we note that:

10. The education system needs to respond to the dynamic technology needs by integrating artificial intelligence, genetic engineering, Internet of Things (IoT) and blockchain in its curriculum. Further, the system should respond to the needs of the 4th industrial revolution, with a decentralized system of delivery that responds to individual skill requirements.
11. Strengthening linkages between universities and industry is necessary to support growth in innovation and its commercialization. The Government could support learning institutions in establishing science parks, innovation hubs and clusters.
12. Integrating the "Jua Kali sector" in the formal assessment and certification system in the qualifications framework should be embraced. In addition, there is need for mechanisms to reimburse employers who support skills upgrading programmes for their employees.

Action: *Ministry of Education; Ministry of ICT, Innovation and Youth; universities and research institutions; private sector; County Governments; and non-state-actors*

Theme 4: Building a Strong Innovation System

Building a strong innovation system supports the creation of innovative ideas, incubation of ideas, protection of breakthrough innovations against competition, and facilitation of demand for innovative products and services. The innovation systems in the country require strong linkages among ST&I actors, innovative financing strategies and goodwill from the Government.

In building a strong innovation system in Kenya, we note that:

13. Universities, private firms, the National and County Governments, and development partners need to collaborate in sharing ideas on innovations, incubating innovation ideas, and providing seed capital and mentorship. Similarly, ST&I actors should collaborate in adopting new approaches and digital technologies to promote ST&I in the country.
14. The National and County Governments, private sector, academia, and development partners need to increase budgetary allocations towards research and development to facilitate scientific, technological, and innovative breakthroughs. This can be supported by holistic implementation of the existing relevant policies and laws on ST&I.
15. In addition, National and County Governments are encouraged to establish an Innovation Fund that identifies promising innovations to incubate, nurture, and support commercialization. Further, commercial banks could come up with funding strategies that identify viability of innovations for financial support.
16. Further, the National and County Governments in collaboration with the private sector, academia, and the development community could come up with targeted measures to identify ST&I innovations by persons living with disabilities (PWDs) for support through funding, incubation, mentorship, and introduction to the market for commercialization.
17. Sealing the loopholes in the existing Intellectual Property Rights (IPRs) regime, and

holistically implementing existing IPR policies and laws serves to incentivize investments in ST&I.

Action: *NACOSTI, Ministry of ICT, Innovation and Youth; Kenya National Innovation Agency; universities and research institutions; Kenya Industrial Property Institute; County Governments; National Council for Persons with Disabilities (NCPWD); development partners; media houses and non-state actors*

Theme 5: ST&I Infrastructure

Growth and development of ST&I requires a new set of infrastructure that includes digital connectivity, broadband communication networks, and smart renewable energy grids. It also requires stronger infrastructure networks to support cooperation in research, knowledge generation, technology transfer, innovation diffusion, human resource development, and raising public awareness on science and technology.

To build a strong innovation system in Kenya, we note that:

18. There is need for the National and County Governments to enact policies that entrench cybersecurity in Government operations, improve resilience against cyber attacks through incident response plans, enhance capacity building in cybersecurity, provide sufficient resources, and increase collaboration with industry stakeholders.
19. To mainstream development of accessible and inclusive digital innovations in public policy, the Government could provide tax incentives and incorporate Internet of Things and Artificial Intelligence in various activities and industries.
20. Developing ST&I infrastructure that accommodates persons with disabilities through adoption of inclusive design in policy formulation and implementation will go a long way in disability mainstreaming.
21. Enhanced collaboration between the Government and the private sector through Public-Private Partnerships (PPPs) is necessary to improve the use of existing infrastructure and in building new ST&I infrastructure.

Action: *Ministry of ICT, Innovation and Youth; National Council for Persons with Disabilities (NCPWD); National Government; County Governments; private sector; development partners; and non-state actors*

Theme 6: Building Resilience through ST&I

For Kenya to manage disasters effectively and efficiently, the preparedness and response of the public sector is vital.

In strengthening disaster management in Kenya, we note that:

22. Disaster management in Kenya is already using ST&I, including the development of early warning systems in floods, and earthquakes. However, there is need to improve the existing disaster management systems to strengthen detection.
23. Disaster management entities in Kenya tend to operate in silos. In this regard, strengthening collaborative efforts among relevant implementing agencies is a priority.
24. To enhance efficiency in disaster risk preparedness, funding, response, and community

level awareness, an appropriate policy framework is required to guide not only disaster risk management but also management of disasters.

Action: *National Government; National Disaster Management; County Governments; private sector; development partners; and non-state actors*

Agriculture

With climate change disrupting farming plans and cropping calendar, adoption of affordable climate smart agriculture technology strategies aimed at increasing productivity, improving resilience, and mitigating climate change is required to enhance productivity.

Regarding agriculture and ST&I in Kenya, we note that:

25. Application of ST&I in the agriculture sector offers solutions in improving food safety, including biotechnologies. To increase the uptake of modern technology, there is need to implement proactive policies and safety regulations, legislation, and institutions; build capacity in scientific methods; protect and encourage private investments; create public awareness and acceptance; and provide adequate resources and strengthen partnerships.
26. With the use of ST&I, youth have the potential to contribute in achieving food security. This can be done by having programmes that build capacities at all levels of education, and the enactment of the Mechanization Bill to enhance mechanization in the agriculture sector.

Action: *State Department for Crop Development and Agricultural Research; County Governments; private sector; development partners; and non-state actors*

Health

Healthcare relies heavily on technological development. This has been evident during the emergence of the COVID-19 pandemic where ST&I has been heavily applied especially through use of simple technological innovations.

To improve delivery of health care service in Kenya, we note that:

27. The rate of return on health care interventions is significant, where every Kenya shilling invested in health care brings about ten Kenya shillings in the economy. As such, there is need to prioritize deliberate investments to strengthen ICT in delivery of health care services across all the 47 counties.

Action: *Ministry of Health; Kenya Medical Research Institute; universities and research institutions; County Governments; private sector; development partners; and non-state actors*

Blue economy

The Blue economy is crucial to Kenya since it drives strategic focus on national ocean resources for economic development.

In exploiting opportunities in the blue economy in Kenya, we note that:

28. Intensifying the application of ST&I will help in exploiting the potential and opportunities in the blue economy sector, including the high-end cruise ship tourism, aquaculture, sport fishing, deep sea mining, wind energy, and boat building.

29. ST&I offers opportunities to enhance capacity to monitor activities in the deep waters and respond to the challenges and threats of piracy and illegal fishing.

Action: *State Department for Fisheries, Aquaculture and Blue economy; County Governments; private sector; and non-state actors*

Housing

With an annual deficit on housing in Kenya estimated at almost 200,000 units, significant effort is required to meet housing demands.

Regarding affordable housing in Kenya, we note that:

30. Incorporation of ST&I in the construction process can lower production costs, including by adopting appropriate building technologies, coming up with innovative housing solutions, and developing environmentally friendly building codes to support development of affordable housing.
31. Developing a comprehensive policy framework for e-waste management will create a conducive environment for affordable housing.

Action: *State Department for Housing and Urban Development; County Governments; Ministry of ICT, Innovation and Youth; private sector; and other non-state actors*

Industrialization

The 4th industrial revolution is here with us, and we need to reap maximum benefits for the economy.

In strengthening industrialization in Kenya, we note that:

32. Integrating technologies related to the 4th industrial revolution such as Artificial Intelligence, blockchain, cryptocurrency and Internet of Things in the curriculum at both elementary, higher education and capacity building among the professionals will facilitate in embracing all the emerging opportunities with the 4th Industrial Revolution.
33. Having a clear legislative framework in place will guide the implementation of the 4th Industrial Revolution. Further, there is need to invest in big data platforms, reliable energy, and Internet connectivity in providing adequate capacity. Good governance also plays a key role in implementing the agenda.
34. Supporting MSMEs to uptake ST&I will facilitate them in addressing various challenges faced. This can be achieved through skills and technology transfer, provision of incentives to encourage innovation, and strengthening partnerships working with MSMEs.

35. Space technology is key in supporting all the pillars of the "Big Four" agenda and the long-term development blueprint. There is therefore need to strengthen the linkages between Government, industry and academia and the private sector in promoting space technology.

Action: *State Department for Industrialization; Micro and Small Enterprises Authority; Kenya Space Agency; Ministry of ICT, Innovation and Youth; County Governments, and non-state actors*

Theme 7: Cross Cutting Issues

The growth and development of ST&I faces various cross cutting issues given the economic, social, demographic, societal and technological changes. Some of the cross-cutting issues include gender disparities, limited inclusion of people living with disability, and poor participation by youth in the ST&I activities.

Regarding the cross-cutting issues in the ST&I in Kenya, we note that:

36. There is limited and fragmented data on ST&I. Various institutions collect data for their own use. There is, therefore, need to review the policy and legal framework to ensure all ST&I data is centrally collected and consolidated.
37. Mainstreaming a gender perspective in ST&I will: address gender disparities in access to resources and opportunities; recognize the abilities and innovative capacities at the grassroots level; and build capacities to access, create, and implement solutions for ST&I. By engaging girls and women in ST&I, evidence shows that the whole society stands to benefit from implementing solutions in life problems.
38. Skills mismatch is among the key issues facing the youth in their participation in the labour market. Thus, providing incentives such as direct technical assistance and training to enable the youth to engage in business and other growth-oriented economic activities becomes a priority in empowering the youth. This includes prioritizing TVET programmes that offer graduates with opportunities for practical learning, and continuously equipping them with appropriate infrastructure and skilled trainers.
39. Technological innovations are necessary to empower PWDs, thus enabling them to function more effectively in the society. As such, investing in education for PWDs at all levels will help in adequately equipping them to participate effectively in ST&I activities.

Action: *Ministry of ICT, Innovation and Youth; Ministry of Public Service and Gender; County Governments; private sector; development partners; and non-state actors*

MOVING FORWARD

The Kenya Institute for Public Policy Research and Analysis (KIPPRA) commits to ensure that these issues raised are communicated with the relevant agencies identified in this communique. The Institute also commits to follow up on the actions proposed during the conference and report on progress made towards implementation of the resolutions.

Action: *KIPPRA*

Thank you all.

Communiqué Presented on 25th June 2021 via Hybrid PPLA Conference Platform.

Signed by:
Dr Rose Ngugi
Executive Director, KIPPRA

Signed by:
Mr Koitamet Olekina
Vice Chairperson, KIPPRA Board

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Abbreviations and Acronyms

4IR	4th Industrial Revolution
ABI	African Biosciences Initiative
ACGG	African Chicken Genetic Gains
ACTS	African Centre for Technology Studies
ADGG	African Dairy Genetic Gains
AGPO	Access to Government Procurement Opportunities
AHP	Affordable Housing Programme
AI	Artificial Intelligence
ADA	Alcohol and Drug Abuse
ALDs	Assistive Listening Devices
ASMCUE	American Society for Microbiology Course for Undergraduate Educators
BAGs	Break Away Groups
CAJ	Commission on Administrative Justice
KNCHR	Kenya National Human Rights Commission
CBC	Competency Based Curriculum
CEMASTEA	Centre for Mathematics, Science, Technology Education in Africa
CGIAR	Consultative Group on International Agricultural Research
CMA	Capital Markets Authority
COMESA	Common Market for Eastern and Southern Africa
COVID	Coronavirus Disease
CUE	Commission for University Education
EAC	East Africa Community
EASTECO	East African Science and Technology Commission
EGH	Elder of the Golden Heart
FAO	Food and Agriculture Organization
FINTECH	Financial Technologies
GBV	Gender-Based Violence
GCI	Global Cybersecurity Index
GCSCC	Global Cyber Security Capacity Centre
GDP	Gross Domestic Product
ICT	Information Communication Technology
ILRI	International Livestock Research Institute
IoT	Internet of Things
IPRs	Intellectual Property Rights
ITCs	Industrial Training Centres
KALRO	Kenya Agricultural and Livestock Research Organization
KBA	Kenya Bankers Association
KCSE	Kenya Certificate of Secondary Education
KEBS	Kenya Bureau of Standards
KEMRI	Kenya Medical Research Institute

KENIA	Kenya National Innovation Agency
KEPHIS	Kenya Plant Health Inspectorate Service
KIPI	Kenya Industrial Property Institute
KIPO	Kenya Industrial Property Office
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KIRDI	Kenya Industrial Research and Development Institute
KITP	Kenya Industrial Training Programme
KMFRI	Kenya Marine and Fisheries Research Institute
KNBS	Kenya National Bureau of Statistics
KNEC	Kenya National Examinations Council
KUSP	Kenya Urban Support Programme
KYEOP	Kenya Youth Employment and Opportunities Project
LMIS	Labour Market Information Systems
MBS	Moran of the Burning Spear
MCDA	Ministries, Counties, Departments and Agencies
MoE	Ministry of Education
MSE	Micro and Small Enterprises
MSEA	Micro and Small Enterprises Authority
MSMEs	Micro, Small and Medium Enterprises
MTP	Medium-Term Plan
NACOSTI	National Commission for Science, Technology, and Innovation
NEMA	National Environment Management Authority
NEPAD	New Partnership for Africa's Development
NGEC	National Gender and Equality Commission
NGOs	Non-Governmental Organizations
NHIF	National Health Insurance Fund
NIP	National Indicative Programme
NIS	National Innovation System
NITA	National Industrial Training Authority
NRF	National Research Fund
NSE	Nairobi Securities Exchange
NUA	New Urban Agenda
NuPEA	Nuclear and Energy Agency
PCA	Principal Component Analysis
PHC	Primary Health Care
PPML	Personalized Print Markup Language
PPPs	Public Private Partnerships
PWDs	Persons with Disabilities
Q&A	Question and Answer
R&D	Research and Development
RDiT	Regression Discontinuity in Time

SDGs	Sustainable Development Goals
SEZs	Special Economic Zones
SMASSE	Strengthening of Mathematics and Science Secondary Education
SME	Small Micro Enterprises
STCs	Sector Training Committees
STEAM	Science, Technology, Engineering, Arts and Mathematics
STEM	Science, Technology, Engineering and Mathematics
STI	Science, Technology and Innovation
TVETA	Technical and Vocational Education and Training Authority
TVETs	Technical and Vocational Education and Training
TWAS	World Academy of Science
UHC	Universal Health Coverage
UNCRPD	UN Convention on the Rights of Persons with Disabilities
UNSESCO	United Nations Educational, Scientific and Cultural Organization
VTM	Virus Transport Media
WHO	World Health Organization
WMD	Weapons of Mass Destruction
WTO	World Trade Organization
YEDF	Youth Enterprise Development Fund

About the Conference

The Fourth KIPPRA Annual Regional Conference (KARC) themed Science, Technology, and Innovation

(ST&I) in Enhancing Delivery of the Big Four Development Agenda was held between 23rd and 25th June 2021 at the Bomas of Kenya in Nairobi. The conference had initially been slotted to take place in Kisumu. However, COVID-19 containment measures implemented by the Government weeks before the conference to reduce the spread of the disease necessitated a shift to a hybrid event. The conference had a limited number of physical participants on special invitation only in observance of COVID-19 protocols. This constituted of KIPPRA Board of Directors, staff, presenters, panelists, media, and exhibitors. Other participants attended virtually.

The event brought together over 800 participants drawn from National and County Governments, universities, non-governmental organizations, research institutions, embassies, banking sector, insurance companies, private sector, civil society, general public, and academia students and faculty.

The objective of the Conference was to share experiences on how ST&I could be utilized to guide the country's transition into a knowledge-driven economy. It presented an opportunity to enhance knowledge sharing on the status of ST&I in the country, its future potential, and lessons from good practices across the National and County Governments, and at the regional and global levels. The Conference also sought to enhance KIPPRA's networking and partnerships.

The broad issues focused on by the Conference included status of ST&I in Kenya, Policy, Institutional, and Legislative Framework, Development of Human Capital, Building a Strong Innovation System, Infrastructure in ST&I, Cross-cutting Issues, Building Resilience with ST&I, Industrialization and ST&I, and a Youth Event.

KIPPRA sees the Conference deliberations and resolutions supporting delivery of the Big Four Agenda on *Enhancing Manufacturing, Food Security and Nutrition, Universal Health Coverage, and Affordable Housing* during and post-COVID-19 pandemic. In the spirit of *Thinking Policy Together,* KIPPRA commits to engage relevant stakeholders for implementation of the Conference resolutions.

Keynote Addresses

Adapted from speech by Hon. Eric Simiyu Wafukho, Chief Administrative Secretary, The National Treasury

and Planning on behalf of Hon. Amb. Ukur Yatani, EGH - Cabinet Secretary, The National Treasury and Planning during the official opening ceremony of the 4th KIPPRA Annual Regional Conference on the role of science, technology, and innovation in enhancing the delivery of the "Big Four" development Agenda

This conference focuses on Science, Technology and Innovation in enhancing delivery of the "Big Four" development agenda. This is timely since the long-term development blueprint, the Kenya Vision 2030, recognizes ST&I as a key foundation to achieving socio-economic transformation through a knowledge-based economy. The "Big Four" agenda, which is part of the Third Medium-Term Plan, is targeted at ensuring there is adequate provision of basic needs to improve the quality of life for all Kenyans. The conference therefore expects participants to explore where more effort is required in ensuring that Science, Technology, and Innovation play its role effectively as an enabler in supporting delivery of this agenda.

Sometimes, ST&I looks far off our daily lives. But science really helps us, by accumulating knowledge necessary to make personal decisions or choices in our daily lives. This including in our kitchen, agriculture, health, and recreation. We apply science in practical purposes to improve the quality of life. When African leaders met for the first Africa Forum for ST&I held in Nairobi in 2012, they agreed to ensure that ST&I is used to solve societal problems such as health, water, ICT, energy, and agriculture to improve the well-being of the people in harnessing ST&I for sustainable development.

Science also helps us in generating evidence that informs policy direction in achieving sustainable development. When KIPPRA undertakes objective research, it generates evidence to inform policy advise shared with the policy makers. In the COVID 19 period, policy makers are guided by science in coming up with measures to mitigate the spread of the virus and support those who fall sick. Further, each day there are innovations that bring in new techniques that support technological development.

A strong ST&I system is characterized by adequate funding of research and development (R&D). The best practice is to spend about 2 per cent of GDP. In the first Africa STI Forum in 2012, African leaders agreed to allocate at least one per cent of gross domestic product (GDP) to R&D. By the end of MTP II, Kenya had achieved 0.79 per cent ,which is below the threshold. Further, a lot of R&D is undertaken by the government with little happening in the private sector, yet it is a key partner for making ST&I an effective and sustainable instrument for development. This affects progress in technological development.

The structure of the economy is important to inform ST&I policy framework. For example, MSEs that dominate the enterprises are not innovating nor adopting advanced technology. They also tend to network among themselves, such that there is no diffusion of technology from large companies. As such, MSEs are yet to experience significant technological progress with their products. How do we strengthen innovation and entrepreneurship in supporting youth employment?

Gender parity in ST&I is known to lead to better or effective ST&I policies and activities. This requiring an all-inclusive approach, with involvement of men and women in the ST&I platform. Despite several measures, women and girls remain grossly under-represented in the ST&I field. African leaders during the third Africa ST&I Forum in 2018 committed to design and adopt policies that promote gender equality in education in general, and specifically in higher education in STEM fields. During this conference, it is important we share the achievements being made in this area and any emerging policy issues.

The fourth KIPPRA annual regional conference provides a platform for policy makers, implementers,

data producers and data users to discuss policy issues to enhance the intensification of ST&I in the national development process. Therefore, participants are expected to share experience and exchange of views and come up with strategies for knowledge creation, technology development, diffusion, and commercialization.

The Chief Administrative Secretary, Hon. Wafukho officially opened the three-day conference and wished participants fruitful deliberations.

Excerpts from remarks by Prof. Walter O. Oyawa, Director General, NACOSTI, During the Opening Ceremony of the 4th KIPPRA Annual Regional Conference on Science, Technology, and Innovation in Enhancing Delivery of the "Big Four" Development Agenda

Professor Oyawa presented on Science, Technology, and Innovation Regulatory Framework and National Research Priorities. The science, technology and innovation sector in Kenya is regulated by the ST&I Act of 2013. The Act provides the legal framework to facilitate the promotion, coordination, and regulation of the progress of science, technology, and innovation to entrench science technology and innovation in the national production system. The Act establishes three key institutions as body corporates to manage the whole ST&I sector. These bodies are the National Commission for ST&I (NACOSTI) to primarily set the national and county ST&I priorities and coordinate the sector across all sector Ministries and in the County Governments; the National Research Fund (NRF) to mobilize resources for the National Innovation System; and the Kenya National Innovation Agency (KENIA) to largely develop and manage the National Innovation System.

As per the Section 54 of the ST&I Act 2013, where any conflict arises between the provisions of the Act and the provisions of any other written law in relation to accreditation, coordination of research institutions or any function of the Commission, the provisions of the ST&I Act shall prevail. Professor Oyawa highlighted that COVID-19 has reaffirmed the importance of ST&I in development for countries and institutions to increase investment in ST&I. It was observed that during the pandemic, countries that leveraged on the emerging technologies such as Big Data, Robotics and Artificial Intelligence, among others, fared better in managing the pandemic compared to those countries with low technological savviness.

In conclusion, he noted that it was crystal clear that investing in ST&I is indispensable for any country that seeks to secure its national security, public safety and inclusive economic development and social progress. He also highlighted the Government's commitment to invest 2 per cent of GDP in research and innovation.

Excerpts from remarks by Prof. George Magoha, Cabinet Secretary, Ministry of Education, delivered on his behalf by Dr Sarah Ruto, Chief Administrative Secretary, Ministry of Education, During the Opening Ceremony of the 4th KIPPRA Annual Regional Conference on Science, Technology, and Innovation in Enhancing Delivery of the "Big Four" Development Agenda

The theme of the conference is in synchrony with the vision and mission of the Ministry of Education where science, technology, and innovation are given priority. Reforms in the education curriculum have delivered the competency-based education curriculum with key competencies such as problem-solving skills, which are aligned with ST&I.

The Ministry of Education had developed a policy and legislative framework for education and training to align the human capital training needs with the Constitution of Kenya and the Kenya Vision 2030. Some of these reforms include the University Act of 2012, the Basic Education Act Number 14 of 2013 that guides basic education institutions, the Science Technology and Innovation Act of 2013, and the Early Education Act of 2021.

Education is important because it is the engine of academic, cultural, socio-economic, and political change in any country. Given its importance, Kenya has seen tremendous growth in demand for education at all levels. The current state of poverty in many countries in Africa has been because of lack of adequate knowledge and skills to enhance productivity and increase national output. Many African countries are endowed with resources that can be exploited to meet the development needs of the countries. Human capital has been recognized as important in the development of any country. Higher education is a prerequisite for a highly industrialized country.

Education helps individuals to acquire knowledge, which opens doors to job opportunities, poverty alleviation, participation in groups, makes individuals aware of their rights, and improves health. The level of education in any country is a measure of the country's human capital base and a measure of a country's technological progress. A highly skilled workforce promotes innovation, efficiency, and effectiveness of countries.

In conclusion, there was need to undertake training and retooling of teachers. This is important in encouraging research and innovation. Additionally, high quality of labour raises efficiency in manufacturing. Proper motivation of personnel and enhanced allocation of resources to the Ministry of Education are important in ensuring the teaching workforce is equipped with ST&I skills. Further, education opportunities should be expanded to solve gender disparities in accessing education.

Excerpts from remarks by Hon. Peter Munya, EGH CS, Ministry of Agriculture, Livestock, Fisheries & Cooperatives, delivered on his behalf by Dr Oscar Magenya, Director of Research and Innovation, During the Opening Ceremony of the 4th KIPPRA Annual Regional Conference on Science, Technology, and Innovation in Enhancing Delivery of the "Big Four" Development Agenda

Access to quality and sufficient food is critical to realize the increasing demand for food by the population. The presenter acknowledged that agriculture is central to meeting the challenges of an increasing population by creating wealth, reducing poverty and managing degradation of natural resources, creating jobs, raw materials, foreign exchange earnings, food and nutrition security, and remains a crucial pillar of the Kenya Vision 2030. Agriculture contributes to national development goals if continuous emphasis is put on positive factors that underpin the remarkable achievement over past years.

The Government is conscious of the critical role of ST&I in modernizing agriculture, specifically food production. The Government is currently implementing the Agricultural Sector Transformation and Growth Strategy (2019-2029), a ten-year strategy aiming to modernize the agricultural sector and stakeholders to align with the strategy requirements. The strategy addresses the challenges in the sectors to deliver the 10 per cent annual economic growth envisaged under the Kenya Vision 2030 economic pillar. The Constitution of Kenya also acknowledges the importance of proper coordination and synergies in the agricultural sector.

Agricultural production in Kenya has been negatively affected by the COVID-19 pandemic and changing factors, including increasing population pressure and sustainable land and environmental management practices, dependency on non-reliable rain-fed agriculture, inaccessible and high input costs, climate change resulting in erratic weather patterns, emerging pests, and diseases, decreasing access to production resources such as credit and technology amidst the increasing poverty levels. Notably, the agricultural sector is constrained by weak research extension farmer linkages, weak interdisciplinary collaborations and partnerships in agricultural research, inadequate capacity building for research, slow adoption of the new and emerging technologies, and gender and socio-economic aspects of agriculture. The presenter indicated that effective and efficient agricultural research that is more dynamic and well-coordinated needs to be developed. In addition, adoption of agriculture technology is likely to increase product quality along the agricultural value chains. Similarly, a logical and well-founded solution-oriented and impactful agricultural research system is pivotal to addressing the challenges.

Implementation of the National Agricultural Research System (NARS) Policy that was enacted in 2012 is currently under review to ensure that the set objectives are achieved. Implementation of the policy was constrained by the failure to bring together all the stakeholders in the agricultural research system. The review of NAS policy aims to streamline, rationalize, and put a consultative approach and consider economies of scale to use current scientific human and physical capabilities and position Kenya as a hub for agricultural research and development in the region.

To create an enabling environment for a vibrant agricultural research industry that contributes to the overarching policies of economic growth, wealth creation, poverty reduction, gender equity, increased productivity, improved livelihoods, and sustainable development, the NAS policy aims to create innovative agricultural sectors and facilitate the development of hybrid crop, livestock, and fish in line with aspirations of the "Big Four" agenda, Vision 2030, SDGs, and Agenda 2063 of the African Union. Further, concerted efforts to address vulnerability to climate change and other external shocks need to initiate policy and institutional reforms to address globalization, and other sector changes to achieve an effective agriculture system.

Excerpts from speech by Amb. Simon Nabukwesi, Principal Secretary, State Department for University Education and Research, Ministry of Education, Delivered on his Behalf by Dr James Mwangi, Director of Research, During the Official Opening Ceremony of the 4th KIPPRA Annual Regional Conference on the Role of Science, Technology and Innovation in Enhancing the Delivery of the "Big Four" Development

Agenda, 24th June 2021

The core functions of the Department are: a) University Education Policy; b) University Education Management; c) Management of Continuing Education (excluding TVETS); d) Public Universities and Public Universities Constituent Colleges; e) Education Research and Policy (Research, Science and Technology); and f) Biosafety Management. It was noted that the functions were guided by the Constitution of Kenya; Universities Act 2012; Science, Technology, and Innovation Act 2013; National Biosafety Act, 2009; Vision 2030; Sessional Paper No. 1 of 2019; Medium-Term Plan III; and National Education Sector Strategic Plan (NESSP) 2018-2022.

The national research priorities on the role of ST&I and the "Big Four" agenda were noted as: Food and nutrition security: Enhanced agricultural productivity, through novel technologies, better management of pests and diseases and sustainable use of soil, water and biodiversity; Reduced post-harvest losses through increased efficiency in food processing, storage, distribution and supply chains; Increased technology up-take through effective technology transfer system, sustainable provision of extension services, farmer education and public outreach programmes; Increased diversity of food sources by addressing the socio-economic, cultural and religious factors that limit the utilization of diverse food sources; and Strengthening environmental governance, mitigation and adaptation to climate change.

Affordable housing: Development of affordable building materials and technologies; Development of technologies for greening the building and construction sector to make it climate smart; Responsive land use and urban planning; Viable and innovative financing models including Public Private Partnerships (PPPs).

Manufacturing: Technologies that enhance efficiency in processing and value addition; Appropriate climate smart manufacturing processes, energy efficiency, effectiveness and diversification; Effective quality assurance and standardization of processes and products; Fabrication of simple power and hand driven tools/equipment; Manufacturing of plant equipment, components and accessories for energy generation; Increased efficiency in the execution of the textile, apparel and leather value chains; and Efficient production of steel, plastics and rubber, paints and adhesives, leather, electrical and electronics, sheet and fibre glass and petroleum products.

Universal health coverage: Novel health care delivery and public health systems supported by modern technologies, including Information Communication Technology (ICT) and Nanotechnology; Promotion of healthier lifestyles and address non-communicable diseases including mental health; New technologies to enhance disease surveillance, prevention, diagnosis and treatment; Disease prevention-focusing on infectious and non-infectious diseases pharmaceuticals, vaccine development, alternative medicine and emergencies; Early diagnosis and treatment of diseases; and Environmental health-focusing on water and sanitation, pollution control, occupational health and safety and effect of climate change on health.

Excerpts from speech by Dr Rose Ngugi, KIPPRA Executive Director, During the Official Opening Ceremony of the 4th KIPPRA Annual Regional Conference on the Role of Science, Technology, and Innovation in Enhancing the Delivery of the "Big Four" Development Agenda, 24th June 2021

KIPPRA is grateful to all participants for attending this conference, both physically and virtually. The conference is organized as a platform for stakeholders to exchange views, share experiences, and learn from each other, as we build a knowledge-based economy. To enhance participation by all stakeholders, the conference has been publicized through various media platforms.

In line with the KIPPRA Act No.15 of 2006, we are mandated to organize symposia, conferences, workshops, and other meetings to promote exchange of views on issues relating to public policy research and analysis. It is for that reason that the 4th KIPPRA Annual Regional Conference is being held. The conference focuses on Science, Technology, and Innovation and its role in improving quality of life by enhancing the implementation of the "Big Four" development agenda.

The conference is organized around eight themes, namely: Status of ST&I and milestones made; Policy, institutional and legislative framework; Development of human capital; Building a strong innovation system, which includes funding for research and development; ST&I infrastructure; Cross-cutting issues, including data, gender and persons with disability; and Building resilience in various economic sectors. In addition, the conference show-cases various innovations including transport, assistive devices technology; access to information by farmers; innovations on ventilators and others in the health sector; among innovations in other sectors.

KIPPRA also undertakes research for evidence-based policy making; capacity building programmes; and organizes platforms for exchange of views. The Institute has been recognized as the second-best Think Tank in Sub-Saharan Africa. In addition, it was awarded a Certificate of Compliance to National Values by the Directorate of National Values and Principles of Governance.

The Executive Director completed by thanking all for their participation and wishing all fruitful deliberations and encouraged them to stay safe by observing the COVID-19 protocols.

Excerpts from speech by Dr Linda Musumba, KIPPRA Board Chairperson, During the Official Opening Ceremony of the 4th KIPPRA Annual Regional Conference on the Role of Science, Technology, and Innovation in Enhancing the Delivery of the "Big Four" Development Agenda, 24th June 2021

The aim of the Institute is to hold the conference in a different County each year. However, this year that was not possible given the constraints with COVID-19. This conference was being held as a hybrid conference to abide by the COVID-19 guidelines while at the same time giving opportunity to all stakeholders to participate. For those who are attending physically, observe the COVID-19 protocols set by the Ministry of Health. The Institute appreciates engaging with all the participants for three days virtually and physically.

The KIPPRA Act No.15 2006 mandates the Institute to organize a conference every year to provide a platform for stakeholders to have conversation, exchange views, share experiences, and learn from each other on a prioritized policy issue. This year's conference focuses on "Science, Technology, and Innovation in enhancing delivery of the 'Big Four' Development Agenda". The Kenya Vision 2030, the country's long-term development blueprint, recognizes ST&I as a key foundation to achieving socio-economic transformation through a knowledge-based economy. The "Big Four" agenda, which is part of the Third Medium-Term Plan, is targeted at ensuring there is adequate provision of basic needs to improve the quality of life for all Kenyans. This is supported by the fact that we apply science in practical purposes to improve the quality of life.

Science is also useful in generating evidence that informs policy direction in achieving sustainable development. When KIPPRA undertakes objective research, it generates evidence to inform policy advise shared with the policy makers. In the COVID 19 period, policy makers are guided by science in coming up with measures to mitigate the spread of the virus and support those who fall sick.

MSEs are yet to experience significant technological progress with their products. This begs the question: How do we strengthen innovation and entrepreneurship in supporting youth employment? Furthermore, gender parity in ST&I is known to lead to better or effective ST&I policies and activities. This requires an all-inclusive approach, with involvement of men and women in the ST&I platform, including enrollment in STEM fields.

The expectation is that the conference would help explore the additional efforts required to ensure that Science, Technology, and Innovation plays its role to effectively be an enabler in supporting delivery of the "Big Four" development agenda. In addition, the conference offers an opportunity for the sharing of experiences and exchange of views to come up with strategies for knowledge creation, technology development, diffusion, and commercialization.

She thanked all for their participation and wished all fruitful networking and engagement.

1.1 Background

Research has shown that countries that can steer Science, Technology, and Innovation (ST&I) processes

Chapter 1: Introduction

towards knowledge-based economies enjoy more economic growth and prosperity. Knowledge and innovation are key drivers for economies to become competitive in today's world market, thus countries could consider embarking on a knowledge-based and innovation-based development process.

Science, Technology, and Innovation (ST&I) has been recognized as one of the prerequisites for socio-economic growth and sustainable development of a country. Kenya's Vision 2030 proposes intensified application of ST&I to raise productivity and efficiency levels across the social, economic, and political pillars of the Vision. The Constitution of Kenya 2010 explicitly places a premium on the generation and management of a knowledge-based economy. Kenya has made significant progress in its ST&I performance. It has a robust institutional and legal framework on ST&I, for instance the Science, Technology, and Innovation Act (2013), institutions such as the National Commission for Science, Technology, and Innovation (NACOSTI), the National Research Fund (NRF), among a large host of other national and regional institutions.

Recognizing the importance of Science, Technology, and Innovation, the Government of Kenya has enacted policies and legislation to guide the country's transition to a knowledge driven economy. These policies are aimed at developing a robust national innovation system that links the demand and supply of ST&I within an enabling environment. As a result, the country has recorded improved performance in the Global Innovation Index, buoyed by good performance in innovation-based indices.

Nonetheless, the ST&I sector has been experiencing various challenges that have slowed down the development of a knowledge-based economy. Among the key challenges are a weak policy framework to facilitate effective integration of ST&I in all sectors of the economy, lack of integration or collaborations "Silo Mentality", and inadequate funding - for instance, although currently 2 per cent of the national budget is supposed to fund ST&I, the amount has decreased over the years. Further, education and training curricula does not seem to align with industry needs, leading to skills mismatch and under-employment. The COVID-19 pandemic came at a time the Government was implementing its

development agenda, referred to as the "Big Four" agenda. This agenda highlights the Government's development blueprint for the period 2017 to 2022, and these are: Food Security, Affordable Housing, Manufacturing, and Affordable Healthcare for all. These are key priority areas by Government to help raise the living standards of its citizens, and deliver on the Kenyan promise as outlined by the Presidency.

The COVID-19 pandemic in the country has resulted in severe socio-economic shock affecting lives and livelihoods. The pandemic has the potential of reversing the economic gains realized, since economic performance in most sectors of the economy have slowed down. For example, in the first quarter of 2020, Real Gross Domestic Product (GDP) grew by 4.9 per cent compared to 5.5 per cent growth in the first quarter of 2019. In the second quarter of 2020, GDP contracted by 5.7 per cent compared to an expansion of 5.3 per cent in the second quarter of 2019. In the third quarter of 2020, the economy contracted by 1.1 per cent, according to the Economic Survey 2020. The contracting economic performance has a direct effect on Gross County Product (GCP). Further, this may exacerbate the national poverty rate, which was 36.1 per cent in 2015/2016.

The focus on ST&I and especially at this time is based on the understanding that science and technology are essential to humanity's collective response to the COVID-19 pandemic. Kenya needs to build resilience and recover from the pandemic, an opportunity that ST&I can offer. Considering the Government's "Big Four" agenda for development, and the protracted COVID-19 pandemic, which impacts development and growth negatively, the role of ST&I cannot be over-emphasized.

It is for this reason that the Kenya Institute for Public Policy Research and Analysis (KIPPRA) organized its 4th Annual Regional Conference themed: "Science, Technology, and Innovation in Enhancing Delivery of the Big Four Development Agenda". The hybrid conference was held from 23rd to 25th June 2021 in adherence to the COVID-19 protocols. The conference brought together state and non-state actors to discuss progresses made, challenges faced and way forward in forging a common front to accelerate the gains of ST&I. During the conference, presentations were made, discussion were held, lessons and experiences shared, exhibitions displayed, and a final conference communiqué drafted. Immense opportunities abound for Kenya to leverage ST&I in the attainment of her development goals and specifically the national priorities as espoused in the "Big Four" agenda.

1.2 Conference Objectives and Expected Outcomes

In view of the above, the 4th KIPPRA Annual Regional Conference (KARC) 2021 broad objective was to provide a forum for policy makers, implementers, data producers and data users to discuss the use of ST&I in enhancing delivery of the "Big Four" development agenda.

The specific objectives were to:

1. Examine the human resource development relevant for ST&I in Kenya;
2. Assess the infrastructure and related policies to support ST&I in Kenya;
3. Evaluate the innovation system in Kenya;
4. Investigate the institutional system and economic incentives to promote ST&I in Kenya; and
5. determine the role of ST&I in building resilience in economic crises in Kenya.

The following were the expected outcomes from the conference:

1. Enhance knowledge sharing on the status of ST&I for future research;
2. Lessons from good practices across National and County governments, and at regional

and global level;
3. Networking and partnership with relevant stakeholders; and
4. Communique on harnessing ST&I in the achievement of the "Big Four" agenda and global commitments.

1.3 Conference Themes

The themes selected for panel discussions capture critical aspects to consider while addressing issues associated with ST&I.

Theme 1: Status with ST&I in Kenya

This theme focused on the position of Science, Technology, and Innovation within the Kenyan context.

1. ***Investment in research and innovation by the public and private sector***
   Research is a source of ideas and knowledge on development of new products and services by both the public and private sectors. New ideas and knowledge drive innovation, which contributes positively to the economy through creation of new markets, diversification of goods and services, creation of job opportunities, expansion of government tax revenue, and economic growth of the country. The conference provided an opportunity for researchers, policy makers, and actors in both public and private sectors to brainstorm investment gaps in research and innovation that could be bridged for sustainable development.

2. ***Access to ICT***
   Information and Communication Technology (ICT) drives innovation, which is important in development of new products and services, and diversification of existing products and services. ICT supports businesses to be more efficient, effective, and prompt in responding to customer needs. The platform brought together players in the ICT sector to discuss what needs to be done to enhance access to ICT in the country.

3. ***Fintechs***
   Financial technologies (Fintechs) enhance efficiency of Small and Medium Enterprises (SMEs). They support financial inclusion, innovation in payment systems, diversification of credit markets, and insurance. The success of the MPesa mobile money platform in Kenya, for instance, has revolutionized digital trade while supporting job creation, sustainability of SMEs, and coverage of the large unbanked and underbanked market. The annual conference ignited debate on the various opportunities created by Fintechs, and the desired policy environment to support the Fintech ecosystem.

4. ***E-commerce***
   E-commerce supports digital trading. Its benefits include cost-reduction for businesses, the ability to reach out to more customers, enhanced access to regional and global markets, efficiency in serving customers, obtaining customer feedback and resolution of customer complaints, and enhanced business visibility. The platform supported dialogue on Kenya's e-commerce ecosystem in the wake of the COVID-19 pandemic, which has disrupted traditional supply chains.
5. ***Status of industrial technology***
   Kenya is a leading technology and innovation hub in Africa. The country has witnessed investment in large-scale telecommunications infrastructure that supports efficient and affordable info-communications services. The infrastructure is critical in making Kenya globally competitive while

creating an environment upon which businesses can integrate to evolving market dynamics for enhanced competition and diversification of the Kenyan economy. Under this sub-theme, public and private sector actors had an opportunity to discuss how industrial technology could drive the realization of Kenya's "Big Four" agenda on manufacturing and the large economic pillar under the Kenya Vision 2030.

Theme 2: Policy, Institutional and Legislative Framework

Within this theme, the stakeholders deliberated on what makes a good ST&I policy objective, coordinating the institutional structures of ST&I, and explored the importance of political economy of ST&I.

1. ***What makes a good ST&I policy objective?***
   A national ST&I policy provides a conducive environment and incentives for investment and harnessing of ST&I for the attainment of a country's development objectives. The policy could aspire to align ST&I programmes to national development goals and market needs; improves technical competencies and institutional capacity for ST&I and R&D institutions; build a robust national innovation system (NIS) that entrenches product oriented multi-disciplinary approach to R&D; strengthens governance and management of the ST&I sector and institutions to make them more efficient and effective. It could also provide a sustainable financing framework for ST&I and protect knowledge production by strengthening intellectual property and regulatory regimes at all levels. For effective implementation of policy, it is important to establish institutional and regulatory environments and mechanisms to track performance of national innovation systems.

2. ***Coordinating the institutional structures of ST&I***
   A well-coordinated institutional system provides essential interactions among diverse groups of actors involved in the ST&I framework in pursuit of a common set of socio-economic goals and objectives for a country. ST&I in Kenya is governed by the ST&I Act of 2013, as the overarching legal framework. The ST&I sector is regulated under various regulatory frameworks that have established various institutions mandated to carry out the relevant functions. Some of the key institutions include NACOSTI, NRF, KENIA, NEMA, KEPHIS, and KEBS, among others. Good institutional structures must ensure effective interactions among ST&I stakeholders, including government, private sector, and academia - what is often referred to as the 'triple helix'.

3. ***The political economy of ST&I***
   The important role of ST&I in achieving the development goals of world economies has been widely acknowledged. In Kenya, the Vision 2030 has identified ST&I as a foundation for economic development. As a result, the Government committed to increase expenditure on ST&I to 2 per cent of GDP. Noting that innovation and use of technology is driven by business and private investors, it is incumbent upon the Government to provide fiscal and policy incentives to attract private sector investments in R&D and adopt technology use. Granted, investments in R&D are high risk and investors need government guarantee as a leverage to inject their funds in ST&I development and commercialization of innovations. Existence of a strong intellectual property regime and promotion of consumption of local technologies are some of the strategies that can foster the growth of a knowledge-based economy. It is also important to note the increased liberalization of the global economy to make local innovations and technologies amenable to competition from advanced countries.

Theme 3: Development of Human Capital

This theme gave attention to education, and the relevance of adequate skills as important drivers to create a knowledge-based economy.

1. ***Does the education system matter?***
   Through ST&I, the Kenya economic blueprint envisages a modern economy in which new knowledge plays a central role in wealth creation, social welfare and international competitiveness. Education and research are the key determinants of the ability to create a knowledge-based economy. The education sector provides a platform for harnessing knowledge and skills in ST&I for global competitiveness. Education and research system must be proactive in addressing the needs of industry to ensure effective synergy. The knowledge-intensive nature of science and technology requires highly qualified and skilled human resources. A pool of relevant and adequate skills must be available for absorption into the economy.

2. ***The role of technology universities***
   The university sub-sector has witnessed growth in the last decade due to establishment of new universities and expansion of existing ones. Some universities have been dedicated as centres of excellence to develop national capacities in key national priority areas. There has been a derailed shortage of science equipment and modern facilities in learning institutions. There is shortfall in qualified and trained science teachers for imparting quality science education in schools. There is limited inter-institutional collaborations and partnerships to facilitate sharing of education and research resources. Therefore, investment in education infrastructure needs to come with deliberate focus on research and development.

3. ***What can TVETs do in propelling ST&I?***
   The growth in the education sector provides a platform for harnessing knowledge and skills in science, technology and innovation for global competitiveness and revitalization of the technical education sub-sector and youth polytechnics. This will raise human capital capacity for research and innovation. Further, there is need for effective linkage between academia and industry in an environment that incentives the adoption of research and development.

4. ***Is the skills level ready for ST&I?***
   A large component of the programmes offered in Kenyan universities consists of arts and social science-based courses. There are fewer courses in Science, Technology, Engineering, and Mathematics (STEM) in the universities. Universities do not have enough sufficiently qualified faculty with the capacity to teach STEM-related programmes of sufficient quality to meet required standards. Another issue is that costs associated with delivering STEM-related programmes are higher than those associated with delivering courses in the social sciences and humanities because of the need to invest in expensive equipment needed in delivering STEM-based programmes. There is need to dedicate specific institutions to support innovation in critical national development sectors. The Competency-Based Curriculum (CBC) fosters creativity in science and mathematics, resulting to increased participation in STEM in secondary and tertiary levels.

Theme 4: Building a Strong Innovation System

Investing in Research and Development, Technology and Innovation process, patenting and intellectual property rights, i-labs, and innovation centres were the sub-themes considered for building a robust

innovation system.

1. ***Investing in Research and Development for quality innovation***
   Research and development play an important role in the innovation process. It enhances investment in technology and future capabilities, which transform into new products, processes, and services. It is also key in developing new competitive advantages driving economic transformation and development. With the current high unemployment rate in Kenya, investing in research and development will thus promote technical learning and innovations, stimulating structural changes, improving firm's competitiveness, and creating more jobs. Under this thematic area, stakeholders will have an opportunity to engage on how to leverage on research and technology as a crucial component of innovation, and highlight the options available for Kenya.

2. ***Technology and Innovation process***
   The technological innovation process consists of a series of phases necessary to implement improvements or develop a new production process, product, or service. They include basic research, applied research, development, engineering, manufacturing, marketing, promotion, and continuous improvement. The processes highlighted convert knowledge into useful products and services that have socio-economic impact to the economy. Additionally, technology has been a building block for technological innovations, serving as a cornerstone to research, design, development, manufacturing, and marketing. The sub-theme provided a forum to highlight how to integrate the inventions and existing technologies to bring innovations to the marketplace.

3. ***Patenting and Intellectual property rights***
   The Fourth Industrial Revolution (4^{th} IR) is a convergence of technologies. A patent gives the owner the exclusive right to prevent others from manufacturing, using, or selling the protected invention in each country. More than 70 per cent of the world's technical information is published only in patent documents. Therefore, whether your interest is in research or product development, patent information is a resource that one cannot afford to ignore. The thematic area will provide a platform to engage on the best ways to avoid problems associated with patenting in making informed and realistic decisions about your intellectual property; unravel the uncertainties surrounding Artificial Intelligence (AI) innovations that do not fit square within any categories we currently have of intellectual property aspects of artificial intelligence and explore how AI impact copyrights, trade secrets, databases and even trade law.

4. ***I-Labs and innovation centres***
   Innovation centres and I-Labs are very key in driving innovation by developing commercially viable solutions to transform lives and spark new business opportunities in key sectors, among them manufacturing, affordable housing, and food security. The centres have also been earmarked to drive research and innovation in information communication technology towards achieving the Sustainable Development (SDGs) and Kenya's Vision 2030. The research centres involvement in interdisciplinary research, students' engagement, collaboration with government, industry and other agencies is important in driving the country's economic growth and development. The thematic area provided a platform to engage on how to leverage on I-Labs and innovation centres towards enhancing Kenya's innovation ecosystem in creating new business opportunities and ensuring full commercial viability in providing solutions and services.

Theme 5: Infrastructure in ST&I

Access to ICT, transport and special economic zones are the sub-themes that covered infrastructure.

1. ***Access to information, communication, and technology system***
   ICT provides the reach to high-speed Internet, mobile broad band, and computing, which collectively can catalyze economic growth and development. Kenya has made tremendous improvements in ICT development and enabled about 95 per cent of the population gain access to ICT devices and equipment. The rate of economic growth has, however, not been commensurate with the rapid developments in ICT. Furthermore, while ICT has the potential to empower the youth and women, progress in empowering them has been slower. The sub-theme would thus focus on how ICT can be harnessed to promote growth and development and empower youth and women, reducing poverty, and more critically, how ICT can be better harnessed to promote ST&I activities in the region.

2. ***Access to roads, energy, and water as enablers of ST&I***
   Infrastructure has to do with the facilities and services that promote economic growth and development. This includes transport infrastructure (roads, railways, and ports), energy infrastructure, ICT, water and sanitation, health, housing, urban development, among others. Clearly, infrastructure is a prerequisite in creating and supporting a business environment that facilitates investment, growth and job creation. Kenya has also invested heavily in building critical infrastructure. This sub-theme is thus aimed at providing an understanding of to what extent infrastructural development has translated to investment, growth, creation of jobs, and promotion of tourism. In addition, the sub-theme helped assess how ST&I has been leveraged to lead to the development of infrastructure in Kenya and in the region. Also, crucially, focus would be laid on how the identified infrastructure have performed as enablers for the development of ST&I.

3. ***Special Economic Zones***
   Special economic zones (SEZs) refer to a broad range of zones that include free-trade zones, export-processing zones, industrial parks, economic and technology-development zones, high-tech zones, science and technology parks, free ports, and enterprise zones. SEZs are effective instruments for helping a country to industrialize if well implemented. Kenya has had the SEZs since the 1970s. The session therefore focused on the extent to which SEZs in Kenya have contributed to the manufacturing and industry sector, their roles in employment creation, protecting the environment and promoting green growth. In addition, the session will assess the application of ST&I in SEZs. Given the dismal performance of SEZs in Sub-Saharan Africa, lessons would also be drawn on global experiences of SEZs and how they have translated to promoting industrial development.

Theme 6: Cross-Cutting Issues

Under this theme, we had 3 sub-themes, namely: availability and use of data, gender perspectives in technology and innovation, and technology for persons living with disabilities as the cross-cutting issues.

1. ***Availability and use of ST&I statistics***
   The availability of data is crucial for evidence-based decision-making and informing policy. The ST&I sector in Kenya is, however, faced with inadequate or limited data availability as acknowledged in the draft ST&I Policy for Kenya. Furthermore, there is limited institutional coordination. For

instance, various actors each collect their own data for their own internal uses or for purposes of monitoring and evaluation. This sub-theme addressed the data collection, storing, dissemination and sharing for purposes of informing policy. Issues of institutional coordination for promoting the availability of statistics would also be explored.

2. ***Gender perspectives in technology and innovation***
Gender equality has been highlighted as one of the 17 Sustainable Development Goals (SDGs). Gender parity in ST&I is known to lead to better or effective ST&I policies and activities. This calls for an all-inclusive approach, the involvement of men and women in the ST&I platform. Despite several measures to enable women and girls as key players in ST&I, women and girls remain grossly under-represented in the ST&I field. The sub-theme thus focused on the following key policy questions: What factors contribute to the continued existence of a gender-gap in ST&I? What are the challenges to effective gender mainstreaming? What can be done to ensure a gender-responsive approach to ST&I policies and activities? How can ST&I be leveraged to support women's development in critical areas such as food and nutrition, technologies in agricultural activities, energy, access to water, and healthcare?

3. ***Technologies for PWDs***
Being abled differently and an integral part of the society, persons with disabilities (PWDs) need assistive devices and technologies that can enable them to perform like their peers who do not have disability. Technological innovations can empower PWDs, enable them function more effectively, and emancipate them from the lack of dignity and self-esteem, such as education and learning, participation in socio-economic activities, access to information and public services, and enhance their safety. The session focused on the availability and affordability of technologies for PWDs, application of ST&I to manufacturing of devices for PWDs. In addition, the aspect of participation of PWDs in Science, Technology, Engineering and Mathematics (STEM) related courses to mainstream them in ST&I.

Theme 7: Building Resilience with ST&I

This theme emphasized on efforts in agricultural technologies, food security and nutrition, water, sanitation and waste management, blue economy and technology, sustainable cities and communities and disaster preparedness and the role of ST&I.

1. ***Agricultural technologies and food security and nutrition***
One of the major global concerns in the twenty-first century is provision of sufficient, safe and nutritious food to all people. Over the years, the world is becoming increasingly food insecure due to population growth, climate change, volatile food prices, unequal food access and inefficient supply chains. With the growing demand for food, solutions need to be developed to feed the hungry nation. Technology plays a vital role at the heart of enhancing food productivity growth. To curb the rising food insecurity in the county, Kenya is focusing on the "Big Four" agenda to ensure that the country is a food secure nation. The purpose of the thematic area provided a platform to engage on how to identify appropriate technologies and build the research and development support systems. Additionally, engagement is required on the role played by the public sector in supporting the implementation of new technologies.
2. ***Water, sanitation, and waste management***
Provision of safe water, sanitation and hygienic conditions is essential to protecting human health, especially during infectious disease outbreaks such as COVID-19. In Kenya, access to safe water, sanitation and hygienic conditions remains a challenge. Only 32 per cent of the rural population

have access to improved sanitation, of which 72 per cent predominantly consist of simple pit latrines providing varied degrees of safety, hygiene, and privacy. Solid waste management remains a major environmental hazard in Kenya. This sub-theme explored opportunities of ST&I to address the challenges faced in access to safe water, sanitation, and hygienic conditions.

3. ***Blue economy and technology***

Blue economy and technology explore how innovators can develop the right business models to capitalize on growth opportunities. This sector is huge and includes offshore renewable energy, ports and harbours, shipping, maritime surveillance, cyber security, aquaculture and ocean conservation. Importantly, 70 per cent of the planet is covered by water, and 90 per cent of global economic trade is transported by sea. The world's seas and oceans present a big business and an important sector to generate more income and create more employment opportunities. The sub-theme brought together policy makers to discuss how technology can be used to harness the benefits presented by the blue economy and have a deeper understanding on implementation of Blue economy concepts.

4. ***Sustainable cities and communities***

Urbanization has led to increased pressure on the environment while accelerating demand for basic services, infrastructure, jobs, land, and affordable housing. Increase in rural urban migration has led to a boom in mega-cities, including Nairobi, Mombasa, and Kisumu. The high concentration of people in cities has caused an increase in poverty levels as the Government struggles to accommodate the increasing population. To ensure safety in the cities, the government is working towards ensuring access to safe and affordable housing and upgrading slum settlements, among other projects including investment in public transport, creating green public spaces, and improving urban planning to ensure sustainability. This sub-theme created a platform to discuss how to efficiently use the available resources in making the cities sustainable by leveraging on ST&I.

5. ***Disaster preparedness and the role of ST&I***

Information and Communication Technologies (ICTs) play a crucial role in disaster management. Timely, predictable, and effective information is vital to the actors involved in rescue operations and decision-making processes. Information systems are key in enhancing situational awareness and two-way communication through recording, exchanging, and processing information. ICTs play a critical role in facilitating the flow of vital information in a timely manner, thus minimizing the disaster risks. Countries have embraced the setting up of early warning and monitoring systems and the provision of emergency telecommunications equipment when disasters strike. This sub-theme focused on the role of ST&I in disaster management at all stages (mitigation, preparedness, response and relief, recovery, and rehabilitation).

6. ***Health systems***

The Kenya Health Sector Strategic Plan 2018-2023 outlines a clear plan whose vision is to transform health systems with a view to achieving universal healthcare. Research and development is one of the key investment areas among the eight investment areas proposed in the document. The health system in Kenya is devolved at two levels of Government, National Government, and County Government levels. In Kenya, quality of health care services, especially primary health care, is not offered across the 47 counties. Moreover, majority of Kenyans are exposed to health care risks and catastrophic expenditure; that is, spending beyond their income levels on health-related issues.

Theme 8: Industrialization and ST&I

The focus under this theme was on industrial development in the Science, Technology, and Innovation spaces.

1. ***Are we ready for 4th Industrial Revolution?***
   Kenya is poised to tap into the benefits of the 4th industrial revolution that promises to transform production, management, and governance systems. Breakthroughs in emerging technologies that include artificial intelligence, robotics, Internet of things, autonomous vehicles, nanotechnology, biotechnology, and quantum computing promise to fundamentally transform Kenya's economy. Technological advancements have improved efficiency and productivity of global supply chains, which have consequently reduced trading costs, opened new markets, and supported economic growth. The 4th KIPPRA annual conference brought together stakeholders from public and private sectors to discuss Kenya's policy environment as a key building block for the 4th industrial revolution.

2. ***Artificial intelligence***
   Kenya was the highest-ranking African country in the 2019 Government Artificial Intelligence (AI) Index at position 52. Despite presenting opportunities attributable to automation efficiency, AI presents threats to traditional jobs such as truck driving, customer service, financial analysis, and law. Investment in research and development for context-specific artificial intelligence is needed to spur the Kenyan economy towards enhanced diversification. Under this sub-theme, stakeholders had an opportunity to discuss how the public and private sectors can harness artificial intelligence for improved diversification of the Kenyan economy.

3. ***SMEs and ST&Is***
   Science, technology, and innovation are associated with enhanced performance and survival of SMEs. Adoption of ST&Is supports product and service diversification, operational efficiency, and enhancement in total factor productivity. Particularly, ST&I is central to the realization of 15 per cent contribution of manufacturing to Kenya's GDP in line with the "Big Fou" agenda and the Kenya Vision 2030. Under this sub-theme, ideas on how ST&I could be harnessed for enhanced sustainability of SMEs in Kenya were discussed.

The Youth Event

The youth are an essential component of a nation's development, owing to their large numbers, their energy, vibrancy, creativity and innovativeness, and other productive potential. Therefore, this theme investigated ways of engaging the youth through 3 sub-themes: opportunities for youth within ST&I, commercializing innovations and youth activities.

1. ***Opportunities for youth with ST&I***
   In Kenya and globally, the youth have a valuable role to play in helping to achieve the country's development agenda as outlined in the "Big Four" agenda and the Kenya Vision 2030. If well tapped, trained and mentored, the youth can benefit themselves and the other segment of the population through ST&I. For example, the youth constitute about 32 percent of Kenya's population, which translates to a large workforce. A discussion with a cross-section of university students and other youth dwelt on their sentiments about their potential, the investment opportunities, their need to succeed in the ST&I field, the training and mentorship opportunities available for them to explore on ST&I, their participation in the agenda-setting for ST&I, how to

address the constraints that they face in wanting to innovate, and how the youth can harness ST&I for job creation, entrepreneurship and empowerment.

2. ***Commercializing innovations***
Inventions, innovations, and new technologies could translate to economic or social benefits or returns to the producers. Finished products and services could access the market where exchanges or transactions can take place. An understanding of the markets for inventions and innovations is therefore key. In addition, an understanding of the commercialization process and pathways towards commercialization would aid in addressing any existing gaps. The sub-theme highlighted the roles played by innovation hubs, incubation centres and technology transfer centres in helping commercialize innovations, financing and other support for commercialization, and adaptation and uptake of innovations. An assessment of lessons or best practices for commercializing innovations was also discussed.

3. ***Youth activities***
The youth benefited from a mentorship session with professionals in the ST&I field on their role in promoting and using ST&I for development and empowerment. A talk on promotion of youth agency in ST&I, and a youth session on how other youth are making progress in ST&I were the key highlights. Songs and entertainment were delivered based on the subject and exhibits of some of the innovations developed.

1.4 Conference Organization and Structure

The format of the conference was designed to appeal to the interests of a multi-disciplinary audience and to maximize interaction of participants and networking. For this reason, and in keeping with the theme of Science, Technology and Innovation, a hybrid conference, both physical and online conferencing, was implemented.

Plenary sessions: All panels had presentations to guide the discussions. The thematic areas formed the plenary discussions. Keynote speakers necessary for initiating plenary sessions were identified based on the objectives of the conference.

Break away groups (BAGS): Research abstracts from the call for papers formed the content for the virtual breakaway sessions. Breakaway sessions enabled direct interactions among participants. Within each session, there was an opportunity to explore the technical assistance needed in overcoming the challenges and barriers, linked to the theme of each group.

Youth side event: A youth side event was held on the first day of the conference. It involved students from various universities in Kenya. The presentations made helped the youth to explore the need for their agency and participation in ST&I and related activities.

Exhibitions: The exhibition spaces attracted relevant stakeholders and an opportunity to network, provide advice, educate, and showcase products and technologies relevant to the theme of the conference.
Rapporteurs: Conference rapporteurs summarized the outcomes of the discussions according to the thematic areas. The rapporteurs highlighted the key issues and potential solutions, and examples of transferable practice.

Conference communiqué: A conference communiqué highlighting the conference resolutions was drafted for adoption at the close of the conference.

1.5 Participants (Description of participants by categories)

The participants during the conference comprised of KIPPRA Board of Directors, staff, and stakeholders from Government ministries, local and international universities, state corporations, Non-governmental Organizations (NGOs), embassies, research institutions, county governments, civil society, private sector, banking sector and insurance companies, and the public.

Table 1: Number of invitations sent and daily attendance Partnerships

The preparation and organization of the 4th KARC 2021 was executed in partnership with the following institutions:

No	Category of Invitations	No. of Invitations	23rd June		24th June		25th June	
			Virtual	*Physical*	*Virtual*	*Physical*	*Virtual*	*Physical*
1	Ministries	23	0	11	1	11	2	6
2	Universities	30	10	112	10	107	20	85
3	State Corporations	58	12	61	15	73	14	52
4	Non-Governmental Organizations	80	3	33	8	19	3	14
5	Research Institutions	21	1	10	3	16	1	5
6	Embassies	66	1	16	0	10	0	7
7	Banking Sector	34	0	3	0	3	0	3
8	Insurance Companies	44	0	8	0	2	0	2
9	County Government	47	2	3	0	5	0	5
10	Private Sector	38	8	56	7	44	3	27
11	Civil Society	34	8	8	7	8	2	14
12	General Public	122	2	24	1	18	0	14
13	KIPPRA Staff	102	49	44	31	48	27	42
14	KIPPRA Board Members	14	10	3	11	2	11	3
15	Academia Students and Faculty	100		68		5		3
	TOTAL	813	106	460	93	371	83	282
			566		464		365	

1.6 Organization of the Report

The rest of this report is organized in chapters as per the eight thematic areas, the sub-themes and youth side event. These discussions took place in panel sessions, panellist sessions and Break Away

Groups (BAGs). Emerging issues and recommendations for each session have also been captured and other supporting documents have been annexed.

2.1 Overview

The session on status of ST&I in Kenya focused on understanding the current state of ST&I in Kenya, gaps that need intervention to promote ST&I, and recommendations that could be implemented for better ST&I outcomes in delivering the "Big Four" agenda. It was chaired by Dr Katherine Getao, CEO,

Chapter 2: Status of ST&I in Kenya

ICTA, and had four presentations, a panel discussion, and a BAG. The topics covered were Trend in ST&I in East and Central Africa; Access to ICT; Role of FinTech in deepening financial inclusion in Kenya; and Status of industrial technology. The session presenters were drawn from institutions involved in ST&I in Kenya and included African Centre for Technology Studies (ACTS), Kabarak University, Kenya Bankers Association (KBA), and State Department for Industrialization, Ministry of Industrialization, Trade and Enterprise Development. The presentations were followed by a panel discussion on the status of ST&I in Kenya and a BAG in which a paper on "Leveraging on Digitalization to Boost Export-Based Manufacturing in Kenya" was presented.

2.2 Trend in ST&I in East and Central Africa

The presentation on Trends in ST&I in East and Central Africa was made by Dr Ann Kingiri from ACTS. The presenter co-authored the chapter on Central and East Africa in the UNESCO science report 2021 themed "the race against time for smarter development".

With the Africa Continental Free Trade area on the horizon, countries are looking at digital tech and transformational infrastructure to boost intra-African trade. Digital payments and locally led data centres have layed the groundwork for Intra-African Trade. Despite these crucial developments, the cost of Internet access remains the greatest barrier, with three in every four Africans lacking access to Internet despite significant investments in infrastructure due to insufficient market competition, thus influencing economic growth. The African Continental Free Trade is largely influenced by access to electricity. In response to African Union's Agenda 2063, most African countries are investing in renewables and grid extension to boost electricity access. Currently, 48 per cent of Sub-Saharan population have access to electricity. Today, more than one third Kenyan households are connected by geothermal energy (KenGen Foundation). Kenya has, for instance, enacted the Energy Act 2019, which elaborates on investment in renewable energy such as solar and wind energy. Kenya is doing

relatively well in investment on renewable energy, but not as good as other countries such as Ethiopia, Uganda, and Central African Republic. Energy is key in promoting key sectors in the economy, such as manufacturing.

Generally, there has been increased Inter-regional research in the East and Central African region, with more collaborations and research initiatives being witnessed. Kenya has largely contributed towards improving capacity for industrialization. The World Bank funded initiatives mainly support agriculture and geothermal energy in Kenya instead of promoting skills lacking in terms of ST&I, compared to Rwanda which has largely invested in areas such as data science, IOT, innovation, teaching and learning of mathematics and science, thus prompting the need for policy intervention. Insufficient number of science and engineering students within the region is also alarming. There is low research effort in the region, with only an average of 1.15 per cent share of GDP going to research and development. Further, Kenya is not in the list of best performing countries in innovation, with countries such as Rwanda, Chad and Ethiopia taking the lead, with the biggest challenge being data and monitoring and little contribution from businesses sector to research and innovation.

Despite increased number of technological hubs, incubators and accelerators, support is needed in terms of seed capital required to accelerate development of innovation hubs, and intellectual protection. Innovators face various hurdles in patenting and the entire process. Out of all countries in the East and Central African region, only six countries have developed the ST&I policy. The development of this policies is motivated by economic growth and competitiveness. These policy initiatives are not aligned to sustainable development agenda (African academy of science report, 2019). The report recommends an interface between STI and other policies such as education, industry, agriculture, and trade with broader key policies in social and environmental development policies.

Among the key regional policy initiatives include the East African Regional Policy for Science, Technology and Innovation (2019-2029), EAC Regional Intellectual Property Policy and EAC Regional Bioeconomy Strategy approved by EASTECO Governing Board on 31 March 2021. The EAC Research and Technological Development Fund promotes market-led research, industrial research and technology transfer, and has been operational since 2018. The fund is financed by member states. Its legal statutes were under development in 2021 and Central African Energy Policy to 2035 (est. 2017) to ensure reliable, efficient energy infrastructure.

Shocks emanate from climate change and other eventualities such as the COVID-19 pandemic. Research has made significant contribution in managing COVID-19. Some countries are developing expertise in climate science with support from the German government through research programmes, graduate studies programmes, and observation networks. During the COVID-19 pandemic, Africa contributed 13 per cent of new or adapted technologies worldwide, including in fields such as robotics, 3D printing and mobile phone apps. As to the extent to which research that promotes sustainability is carried out in the region, research by UNESCO capturing 56 topics between 2012 and 2019 established that within the region, most research done revolves around, climate ready crops, greater battery efficiency and eco-construction materials, which have a greater role to play in promotion of ST&I.

2.3 Access to ICT

The presentation was done by Dr Moses Thiga, Senior Lecturer, Information Technology and Director, Research, Innovation and Outreach from Kabarak University. He began by highlighting on the 11 pillars of the 4th industrial revolution mainly focusing on cyber security, AI and Big Data analytics;

Second on Big data platforms mainly log Data Apps, structured Databases provided by Oracle and Business intelligence; Third on Augmented reality and outputs, addictive manufacturing (3D printing), autonomous robots; and Forth on Industrial Internet of things from User analytics through processing tools to machine and sensors.

The industry 4.0 Readiness Online Self-Check was also highlighted, which included the levels of readiness of a country in terms of ICT. Level 0 &1 comprised of outsiders and beginners and are regarded as newcomers. Level 2 comprised of intermediate and is categorized as learners and finally level 3&4 are categorized as leaders and comprise experienced, expert, and top performers in ICT.

Two issues emerged during the presentation. Does the 'average' Kenyan Innovator have access to the ICT's required to participate in the 4th Industrial Revolution? And does the 'average' Kenyan enterprise have access to the ICTs required to participate in the 4th Industrial Revolution?

Further, there is need for policies to be put in place to enable innovations and the use of 4th Industrial revolution (AI, IoT). We should not just be end users of technology, but we should contribute to its development.

2.4 The Role of FinTech in Deepening Financial Inclusion in Kenya

This presentation was done by Dr Samuel Tiriongo, Director, Research and Policy at the Kenya Bankers Association (KBA).

FinTech was identified as playing an important role in deepening financial inclusion by improving efficiency of the financial sector. FinTech is challenging traditional structures through creating efficiency gains in the financial services value chain, reducing information asymmetry, and supporting payments at lower cost. They crowd in MSMEs, serve as an alternative to the traditional banking, and support credit profiling. This notwithstanding, there is need to balance the trade-off between benefits generated by FinTech and potential risks and vulnerabilities. The key issues needing interventions include undue competition from growing unregulated entities, cyber-attack risks, and employment.

Addressing the risks and vulnerabilities is possible through initiating policy interventions that are geared towards narrowing the large existing infrastructure gap, addressing the perennial race between fast-moving innovation and the slower pace of regulation, and considering the trade-off between productivity and employment creation.

Globally, there have been two main FinTech models; traditional and emergent FinTechs. Traditional FinTech collaborates with incumbent financial service providers as technology providers through traditional pricing models, while emergent FinTech constitute a new category of FinTechs that partner with banks and through new engagement models or simply displacing financial institutions. There is need to balance innovation and regulation for enhanced collaboration and increasing customer confidence. The industry input approach should be embraced to support in determining obstacles to innovation.

Regulatory sandbox should be encouraged to support flexible experimentation for risk minimization. Flexible policies will further promote FinTech businesses while RegTech will support use of technology to reduce cost, complexity, and time in regulatory reporting. With fading geographical boundaries in

the digital world, international cooperation should be enhanced.

The FinTech ecosystem comprises of financial institutions, regulations and government, start-up ecosystem, and other players. The regulatory environment comprises of innovation schemes, regulatory sandbox, industry input, Fintech regulation wing, international cooperation, and RegTech. The Government enhances the sector through tax incentives and funding. Financial institutions comprise open platforms, corporate ventures, innovation labs, FinTech partnerships, and accelerator sponsorship. The start-up ecosystem further comprises of start-ups and entrepreneurs, and mentors. Collaborations that include incubators, accelerators, and hackathons form integral tenets of the start-up ecosystem. Venture firms, angel investors, and crowdfunding partners are key sources of start-up financing. Other key players in the start-up ecosystem that were identified include consumers, digital identity providers, switches and gateways, research, academia, and universities. It was noted that whereas developed countries are focused on facilitating innovation, consumer protection, and risk reduction, emerging and frontier market countries are focused on financial inclusion.

Majority of enterprises (94 per cent) were reported to use mobile money to pay business bills such as electricity and water bills, 90 per cent to pay suppliers, 88.1 per cent to receive payments from customers, while half of the MSMEs were reported to use Internet banking to pay suppliers and receive payments from customers.

In conclusion, there is need for a multi-faceted approach to understanding the FinTech ecosystem, with special focus on innovation schemes, regulatory sandbox, industry input, FinTech Regulation Wing, international cooperation, RegTech, tax incentives, government funding, open platforms, corporate ventures, innovation labs, FinTech partnerships, accelerator sponsorships, start-ups and entrepreneurs, mentors, incubators, accelerators, hackathons, venture firms, angel investors, crowdfunding partners, consumers, digital identity providers, switches and gateways, research, academic, and universities. Further, financial inclusion should be a focus for Kenya as an emerging and frontier market.

2.5 Status of Industrial Technology

The presentation on the Status of Industrial Technology was made by Stephen Odua, Director, Private Sector Development, State Department of Industrialization Ministry of Industrialization, Trade and Enterprise Development. The presenter noted that one of the core mandates of the department lies in business innovation and incubation that closely links to ST&I. The presenter highlighted the key policy frameworks guiding the sector, including Kenya National Industrialization Policy (NIP) Framework which aims at making Kenya a leading industrialized nation in Africa with a robust, diversified, and globally competitive manufacturing sector. In addition, Sessional Paper No. 9 of 2012 (2012-2030) seeks to increase the contribution of the manufacturing sector to >15 per cent of GDP, improve productivity and value addition by 20 per cent, increase share of FDI in industries by 10 per cent, and increase local content for export to at least 60 per cent. Also, the Kenya Industrial Transformation Programme (KITP) is an integrated plan to implement NIP to guide the country on its path to industrialization by boosting local production, expanding local and regional markets, and taking advantage of global market niches. Notably, it is one of the first projects in the region supporting the Digital Transformation Initiative, a plan for building an inclusive digital future across Africa.

The key strategies being employed to foster industrialization under KITP include raising the share of Kenyan products in the regional market from 7 to 15 per cent; developing niche products through which Kenya can achieve a global competitive advantage; establishing an Industrial Development Fund with

a minimum of Ksh 10 billion for long-term financing of manufacturing enterprises; and increasing by 20 per cent the share of manufacturing in total MSMEs output. Under KITP, the priority sub-sectors are agro-processing, including processed high-value crops and fisheries, textiles and apparel, and leather.

The industrial sector is also keen on embracing environmentally sustainable technologies that protect the environment, are less polluting, use all resources more sustainably, recycle more of their wastes and products and handle residual wastes in an environmentally friendly manner. Similarly, following the Fourth Industrial Revolution Technologies pathway, technologies such as Artificial intelligence, robotics, the Internet of Things, 3D printing, genetic engineering, quantum computing, and other technologies are beginning to take centre stage. The presenter also pointed out that e-commerce is increasingly becoming the next economic driver, hence the need for our traditional industries to re-engineer and adapt to the global changes.

The presenter also noted that nanotechnology is also gaining grounds in the industry, with its application in information technology to enable smaller, faster, more energy-efficient, and powerful computing and other IT-based systems; more efficient and cost-effective technologies for energy production, including solar cells, fuel cells, batteries, biofuels; cancer treatment drug development, medical tools, and diagnostic tests; foods and beverages: advanced packaging materials and sensors.

2.6 Panel Discussion: Status of ST&I in Kenya

The panel discussion on status of ST&I in Kenya was moderated by Dr Katherine Gateo, CEO, ICTA. Dr S. Solomon Darnell of @iLabAfrica, Strathmore University discussed ST&I policy domestication focusing on the need to change the way we mould policy for Sub-Saharan countries, which would be different from that of first-world countries. On policy domestication, Dr Solomon highlighted the need to change aspects of ST&I policies from developed countries to fit in/domesticate them to developing countries, instead of trying to follow the path of industrialized countries. This ties the need to research on different ways and better ways to engage technology, asking the right questions about technology and right questions about innovations.

2.7 Presentations from the Break Away Groups

Beatrice Kinyua presented a paper on "Leveraging on Digitalization to Boost Export-Based Manufacturing in Kenya". The presentation begun by noting that manufacturing is outlined in Kenya's "Big Four" agenda, the current national development strategy, as one of the four transformative sectors aimed at creating 2 million more jobs by 2022 while increasing the sector's GDP share contribution to 15 percent. Regional trade has great potential in enhancing Kenya's industrial capabilities as most manufactured exports are destined to developing countries especially in Africa. Studies have shown that adoption of digitalization has been proven to reduce the overall production costs by 90 per cent while facilitating regional integration, hence its vitality as a cost saving mechanism especially in this period of the COVID-19 menace. Unfortunately, Kenya's overall exports of goods and services as a percentage of GDP have been declining over the years from 20 per cent in 2013 to 12 per cent in 2019. More profoundly, the share of manufactured exports to total merchandise exports was 31 per cent in 2019 compared to the world's average of 68 per cent within the same period. Additionally, the share of manufacturing value added has been on a decline from 12.79 per cent in 2012 to 7.54 per cent in 2019, indicating de-industrialization.

In contrast, the presentation noted that Kenya has been ranked third in Sub-Saharan Africa under the Global Innovation Index due to its digital capabilities and regional dominance in internet connectivity, mobile money services and ICT development. 95 per cent of Kenya's manufactured exports are mostly of low and medium-low technology intensities, with only 4.6 per cent of exports comprising high technology intensity. To assess whether digitalization boosts Kenya's export-based manufacturing, the presenter adopted panel data gravity model and applied the Poisson Pseudo Maximum Likelihood (PPML) using data on exports from the top major trading partners. The analysis covered the period 2013 to 2018. Digitalization was measured using indicators from the World Bank Global Innovation Index (GII) combined into a composite index (DigiIndex) examined by the principal component analysis (PCA) and included in the gravity model as an independent variable.

The key findings were that digitalization was highly significant, indicating that its adoption would boost export-based manufacturing in Kenya by 138 per cent. Other variables that were found to be significant in the study were the GDP and exchange rate of Kenya's trading partners, which had a positive effect on export-based manufacturing. The distance between the trading nation's capital cities and membership to a regional trade agreement were significant but had a negative effect on manufactured exports. Trade openness had no significant effect.

The presenter highlighted that a more proactive and streamlined approach should be considered and adopted by line ministries in charge of industrialization, ICT, and trade. This is through mainstreaming digitalization into the industrial policy. As such, the paper proposed that the National Digital Industrial Policy be developed. Similarly, efforts to link the development of technology hubs such as the Konza Technopolis City to the industrial parks and Special Economic Zones (SEZs) be made. This will ensure that manufacturing industries are linked with the new technologies, hence the integration of the digital techniques and skills into the manufacturing processes.

There is need to harness Kenya's digital capabilities characterized by the advanced telecommunication and mobile money sectors by the manufacturing sector. In this regard, the guiding framework of ICT, that is the National ICT Policy and the Digital- Economy Blueprint, should be reviewed to incorporate linkages between manufacturing and digitalization. This would ensure adequate facilitation of export-based manufacturing entities to embracing digital technologies. It is prevalent to promote linkage of the export-based manufacturing in harnessing the power of ICT especially through increased e-commerce sales to the regional markets.

Budgetary allocation should also consider allotting funds directly to the other sub-sectors prioritized under the "Big Four" agenda within the manufacturing sector, such as steel and iron, lime, cement, fish-processing, oil, mining and gas and assembly of information technology (IT) related parts.

2.8 Emerging issues and Recommendations

The emerging issues included low availability and access to seed capital to accelerate development of innovation hubs and enhance intellectual property protection, whether the average Kenyan innovator and enterprise has access to the ICT required to participate in the 4th Industrial Revolution, how best to tap the enormous potential of ST&I to augment human intelligence and to radically alter how we access products and services, gather information, make products, and interact, and the potential of digitization to boost export-based manufacturing in Kenya to the tune of 138 per cent.

Recommendations

1. Government to consider enhancing budgetary allocation to seed capital for research and development as the main source for scientific breakthroughs and innovations.
2. Policies to be formulated and implemented, providing targeted incentives to local innovations by the youth, women and persons with disabilities to support the 4th Industrial Revolution (AI, IoT).
3. Private sector to take lead in creating critical solutions to scale new business models, develop new ways of delivering services, and increase the competitiveness of local markets. All these solutions require innovative approaches to expand opportunities and mitigate risks associated with this new technology.
4. Stakeholders from the public, private, and development sectors to embrace a multi-faceted approach to understanding the FinTech ecosystem, with special focus on innovation schemes, regulatory sandbox, industry input, FinTech Regulation Wing, international cooperation, RegTech, tax incentives, government funding, open platforms, corporate ventures, innovation labs, FinTech partnerships, accelerator sponsorships, start-ups and entrepreneurs, mentors, incubators, accelerators, hackathons, venture firms, angel investors, crowdfunding partners, consumers, digital identity providers, switches and gateways, research, academic, and universities.

3.1 Overview

This session on Policy, Institutional and Legislative Framework discussed the strategies that stakeholders must put in place to create robust legal and institutional environment that will enhance ST&I uptake to foster rapid industrial growth and development. The session was chaired by Dr Linda Musumba, Chair, KIPPRA Board, and covered the following topics: Role of Ombudsman and

Chapter 3: Policy, Institutional and Legislative Framework

Governance in the Promotion of ST&I Programme and Practices; Policy, Institutional and Legislative Framework: ST&I in Enhancing the Delivery of the Big Four Agenda; and Linking Jua Kali to Modern Technology and Innovation for Wealth Creation. The session presenters were from diverse institutions and organizations such as Research and Information System for developing countries (RIS), India; Kenya National Federation of Jua Kali Associations, and Ombudsman Commission. The presentations were followed by a panel discussion and a Break Away Group.

3.2 Policy, Institutional and Legislative Framework: ST&I in Enhancing the Delivery of the "Big Four" Agenda

The presentation was made by Dr Sachin Chaturvedi, from Research and Information System for developing countries (RIS), India. The presenter began by noting that ST&I is essential in fostering rapid industrial growth and development. To effectively benefit from ST&I, it was noted of the need to create links between universities, research labs and MSMEs clusters for knowledge sharing, technology transfer, testing, certification, and quality improvements. It was noted that effective multidimensional legislative framework was critical in mainstreaming inclusion. Moreover, proper governance mechanism was key to enable ST&I to achieve the balance between growth and sustainability. This could be enhanced by promoting access, equity, and inclusion.

Mainstreaming of ST&I in all sectors of the economy is encouraged to ensure that citizens benefit from acquisition and utilization of available ST&I capacities and to build a knowledge-based economy for improved quality of life. Through ST&I policy, the Government could harness the collective talents and skills needed to drive the growth of economy through achievement of the Kenya Vision 2030 and other development agenda in the country, such as the "Big Four" agenda and MTP. Equally important is the need to create an enabling environment where ST&I skills can be applied into innovative competencies

and opportunities to expand our industries and business enterprises. Despite these opportunities, implementation of ST&I policies, legislative framework and projects is facing immense financial, human and capital implications that will need a complete paradigm shift in the way ST&I is funded. In conclusion, legislation at the national and county level needs to be streamlined to enhance smooth implementation of ST&I policies and legislative frameworks to allow for diffusion of new innovations in the country.

3.3 Role of Ombudsman and Governance in Promotion of ST&I Programme, Policies & Practices

The presentation was delivered by Washington Asati, Ombudsman Commissioner (PLWD-Hearing)

The presentation highlighted the mandate of the Ombudsman Commission as involving redressing maladministration through handling of public complaints, promotion of access to information, setting governance and service delivery standards. The commission is also instrumental in diagnosing systemic failures and weaknesses in service delivery, promoting access to justice through complaints handling, and capacity building in the public sector. Additionally, the commission promotes constitutionalism and human rights by playing a watchdog role on transparency and accountability, and enforcing national values and principles of governance and enforcing access to information.

The presenter emphasized the important role played by ST&I in promoting development. ST&I is a key enabler of Kenya's long-term development aspirations of becoming a globally competitive and prosperous nation offering a high quality of life to its citizens. Thus, integrating ST&I in social, economic, and governance policies was seen as important in facilitating evidence-based policy making. Therefore, there is need to enhance governance, coordination, and a rolling out a database on the state of ST&I in the country to facilitate public safety and national security through deployment of frontier technologies in rapid response to incidences.

This notwithstanding, it was noted that ST&I faces governance challenges that include inadequate ST&I infrastructure, insufficient, uncoordinated, and fragmented investments in ST&I. Also, limited coordination across various sectors of the economy, low awareness among the citizenry, and limited collaboration among key players in the ST&I sector hinders its full potential.

Another issue that was raised was the role of the ombudsman in promoting ST&I. The office promotes use of scientific advice to reinforce public trust in policy through enforcing proactive disclosure of information obligation on public and private entities. The use of digital tools to improve policy design and tackle misinformation and disinformation by enforcing computerization records in line with the Access to Information Act, 2016 is also done. The office of the ombudsman also encourages creation of awareness among the citizenry as instrumental in enjoyment of human rights.

In conclusion, it is necessary to re-introduce a research and development indicator in the national performance contracting framework. The indicator was last included in the 10th edition of performance contracting guidelines for the 2013/14. This will mainstream ST&I in MCDAs and attract funding for enhanced research and development in the area. Expanded investment in ST&I could address the challenge on inadequate infrastructure. Further, coordinating the fragmented investments in ST&I, promoting awareness among the citizenry, and enhancing collaboration among stakeholders could enhance application of ST&I in Kenya's policy, institutional, and legislative framework.

3.4 Linking Jua Kali to Modern Technology and Innovation for Wealth Creation

The presentation on linking Jua Kali to modern technology and innovation for wealth creation was made by Mr Richard Muteti, the CEO Kenya National Federation of Jua Kali Associations and the Chairman, COMESA Business Council SMEs Work-Group. The presentation provided an overview, general characteristics and challenges that face the Jua Kali sector in Kenya. It also provided focus on ways to link Jua Kali sector to modern technology and innovation and suggested interventions.

The Jua Kali sector consists of artisans, producers, or manufacturers and accounts for more than 86 per cent of the total persons engaged in employment while contributing up to 33 per cent of the county's Gross Domestic Product (GDP). The general characteristics of the Jua kali sector were identified as: small independent enterprises producing for a well-defined market; small scale operations; rely on low cost raw materials, low energy costs, low labour costs, reliance on indigenous resources; flexible and often small production units with low capital formation; largely labour-intensive units with low-level technologies; ease of entry and exit; skills acquired outside of the formal sector/informal acquisition of skills; flexibility in hours of operation; low incomes; unregulated and competitive markets; linkages to other sectors (including the formal sector), and low usage of formal credit facilities due to lack of collateral securities.

Despite its immense contribution to the economy, the Jua Kali sector is faced with a myriad of challenges such as: insufficient finance, business management and technical skills; limited access to appropriate affordable credit facilities; and limited standardization and patenting issues, which are not collectively addressed leading to poor quality products. Additionally, the Jua Kali sector is compounded with insufficient market for their products; and prohibitive tax regime that discourages most of the innovators in the sector. Further, limited opportunities to do business with the National and County Governments and lack of ownership of the land where they operate have continued to hinder full potential of the sector. The presenter also observed that the Jua Kali sector suffers from limited opportunity for international link programmes, access to affordable and reliable micro insurance facilities, HIV and AIDS scourge. In conclusion, the uncoordinated and weak linkages between Jua Kali associations and institutions, coupled with ineffective representation in institutions that make decisions, affects the Jua Kali sector negatively. Therefore, there is need for effective implementation of policies and legislative framework to support the expansion and growth of the Jua Kali sector through application of ST&I capacities.

From the presentation, it was noted that technology and innovation will increase productivity and competitiveness, leading to new and better goods and services by:

1. Skilling the sector
2. Providing funding and affordable credit
3. Creating and providing modern worksites
4. Providing modern machinery and equipment
5. Providing affordable and reliable micro insurance products and facilities
6. Facilitating technological transfer through backward and forward linkages, and benchmarking, among others

3.5 Panel Discussion: Policy, Institutional and Legislative Framework in ST&I

The panel discussion on the role of policy, institutional and legislative framework in ST&I discussed several issues including the key legislative, policy, institutional and regulatory framework guiding the development of the sector. The panelists were Dr Humphrey Njogu from KIPPRA, Eng. Edward Karani from MSEA, Ms Caroli from National Industrial Training Authority (NITA) and Mr Robert Murima from Swahilipot Hub. Dr Njogu emphasized that the country has a rich pool of strategic documents on the direction the country needs on matters ST&I. However, the challenge lies with the implementation of the projects contained in the policy documents. It was mentioned that not much have been achieved for instance for the targets set under the Kenya Vision 2030, hence the need to prioritize the implementation and policies on ST& I.

Eng. Karani noted that the key policy direction taken by the Government in fostering ST&I includes establishment of different agencies such as NACOSTI, NRF and KIRDI. He re-emphasized that the challenge lies with the implementation of the policies in silos whereby the process is un-seamless, un-coordinated and fragmented. It is also not clear how to provide the linkages. He noted that there is need to provide a landscape for technological transfer between large corporations, government and research institutions through continuous activity engagement. There is also need for collaboration between agencies on information exchange and transfer of skills.

Ms Caroli first highlighted the critical role of the NITA in providing linkages with the industry to ensure the skills gap identified are met through training to meet the demand of the industry. Further, NITA conducts analysis on the labour market demand, collects and analyses data to inform strategies on labour market demand, and provides certification of the skills to the players of the informal sectors. Ms Caroli noted that the demand for STI is high, especially with emerging technologies that are raising the level of efficiency in the industry. Mr Robert Murima from Swahilipot Hub, which links arts and technology, identified lack of adequate STI data to quantify the contribution of STI to the economy and the challenge in aligning education and training to an integrated approach.

3.6 Presentations from the Break Away Groups

The break-away group on the theme of Policy, Institutional and Legislative Framework was moderated by Dr Leonard Mabele. One presentation on application of public, private partnership for enhanced development of ST&I in Kenya was made by Dr Daniel Mutegi Giti. The presentation highlighted the possible contribution of Public Private Partnerships (PPPs) models in the development of ST&I in Kenya to fast-track the achievement of the Kenya Vision 2030 goals.

The achievement of the Kenya Vision 2030 requires application of PPP for enhanced access to knowledge and technology. Application of PPPs help to stimulate ST&I sector in the country by creating ways through which the public and private entities can work together to define project objectives, deliverables, capital injection, innovation, efficiency, effectiveness, and whole lifecycle concept of projects. However, despite the existence of the ST&I policy, strategy and sectoral plans, the country is still reeling from under investment in ST&I and, as such, there is need for stakeholders to re-engineer the sector.

The implementation of PPPs in the ST&I sector will bring about ability to leverage the strengths of partners, including interdisciplinary coordination, operationalization economies of scale in STI sector, cost effectiveness, and leverage on technology. This will make it possible for knowledge and skills transfer and overcoming information and behavioral barriers to the growth of STI, and availing

affordable financing, optimizing utilization of resources to make projects complete on time and achieving value for money for such projects.

Engaging the private sector through the PPPs will help to address issues that hinder the achievement in the ST&I sector. These issues include inadequate financing, training, capacities, infrastructure, and related services for ST&I. Other issues include the legal, technological, structural, and administrative issues, underdevelopment of the ST&I sector, and low private sector participation in ST&I and research. Therefore, there is need to address the poor coordination of ST&I between different players in Kenya.

In conclusion, the PPP Act of Kenya 2013 supports the ST&I sector by providing for participation framework of private sector players in the financing, construction, development, operation, and maintenance of infrastructure, and other development projects in the public sector, which can be done through concessions or other contractual engagements. Therefore, to increase application of PPPs in ST&I, there is need for streamlining the legal relationships and agreements that lead to efficient project implementation and completion.

3.7 Emerging Issues and Recommendations

Some of the emerging issues on the presentation and panel discussions on policy, institutional and legislative framework in relation to ST&I were:

1. The ST&I policy framework is not well coordinated and mainstreamed to support sustainable development in the country'
2. Limited public funding of R&D makes it difficult to put in place an ecosystem for ST&I growth and expansion at the national level. ST&I data is inadequate to quantify the contribution of ST&I to the economy.
3. Misalignment of education and training needs to change the narrative of students to move towards integration.
4. There is limited awareness of the applicability of PPPs for infrastructural, ST&I development and service delivery in Kenya.

From the presentation and panel discussion, the proposed recommendations to enhance implementation policy and legislation framework in the acceleration of ST&I included:

1. The need to establish policy and legislative framework to enhance stronger connect with regional innovation systems. It is through close collaboration regionally and internationally that the country can benefit from ST&I capacities.
2. Enhanced public funding of research and development and prudent use of the funds to enhance ST&I capacities and capabilities in the country, including the informal sector.
3. Alignment of education and training needs to change the narrative of students to move towards integration
4. Restructure institutional framework and PPP laws in a way they are suitable for all the sectors, including ST&I for PPPs application in infrastructure and ST&I development.

Chapter 4: Development of Human Capital

4.1 Overview

The session on development of human capital gave attention to education, and the relevance of adequate skills as important drivers to create a knowledge-based economy. The session chaired by Dr Dinah Samikwo, Board Member at KIPPRA, covered the following topics: Educational system and ST&I; Access to education in 4th IR; Re-tooling and upgrading skills to match industry expectations; and Key lessons on capacity building on emerging technologies. The session presenters were drawn from institutions involved in development of human capital, which included National Industrial Training Authority (NITA); Lake Hub; National Commission for Science, Technology, and Innovation (NACOSTI), Strathmore University, Kabarak University and African Centre for Technology Studies (ACTS). The presentations were followed by a panel discussion and a Break Away Group (BAG).

4.2 Educational System and ST&I

Mr Stephen Ogenga (Director General, National Industrial Training Authority (NITA), made a presentation on development of human capital: The re-tooling and upgrading of skills approach. The presentation highlighted that regulating and implementing industrial training is guided by the Labour Market Information Systems (LMIS) and research and design through its Sector Training Committees (STCs). STCs is an arm of the NITA Board that ensures constant linkage with industry's economic sectors to inform the existing skills gaps and the course content delivered at the Industrial Training Centres (ITCs). In turn, the ITCs produce graduates with the relevant competence for "essential services" that meet the demands of industry.

The presenter noted that 80 per cent of businesses are in the informal sector, characterized by: ease of entry, reliance on indigenous resources/existing resources, small scale operation, mobile financial transactions that are not necessarily banked, and labour-intensive technology where skills are acquired outside the formal school system. Formal employment is not absorbing new entrants at the supply rate. To bridge the existing weak linkages between economic trends and occupational requirements,

NITA regulates the training of persons engaged in industry including: apprentices; indentured learners; attachés; interns; and workers. They undergo skilling, upskilling and reskilling initiatives derived from approved NOS and QPs. To enhance productivity in the gig economy, the Government together with other social partners have increased the investment in expansion of industrial training programmes in the centres to respond to the needs of industry.

The NITA industrial training approach targets the up-skilling and re-skilling of persons engaged in formal, non-formal and informal sectors in demanded areas with an annual output of 200,000-persons, accounting for about 5 per cent of the technology transfers required to service the human capital demands of the industries.

NITAs contribution to developing human capital under the COVID-19 environment includes development of artisan and craft persons, who are at the base of production pyramid, forming the bulk of the skilled workers in production, machine operations, servicing, and maintenance. This is done through NITA's ITCs and other partner institutions. To satisfy the bulk of beneficiaries at the base of the skills pyramid, NITA has initiated a digital delivery approach to cater for the 10 per cent cognitive component of the competence acquisition. The model will embrace a flexible training model and a block chain certification product. NITA partners with the Kenya Youth Employment and Opportunities Project (KYEOP) to address the skills mismatch in the youth by providing training and work experience through apprenticeship model. This incorporates both formal and informal industrial sectors and targets to benefit 70,000 youth.

Among the challenges highlighted in the presentation facing the industrial skilling sector include latency in the integration of the "Jua Kali Sector" in the formal assessment and certification system as provided for in the qualifications framework. In addition, there is low absorption by employers in embracing skill upgrading programmes of their staff as new training programmes get developed. Further, there is latency by the industry and other players in technologically advanced units to offer attachment to opportunities to support knowledge transfer and trigger innovation. There is also inadequate innovative, portable and digitally driven partnerships to ensure that beneficiaries are enabled for decent work, fourth industrial revolution and gig economy.

Ongoing mitigations in the industrial skilling sector include catalyzed resource mobilization with strategic local, regional and international partners. There is also priority uptake and implementation of the recognition of prior learning policy for qualification awards to the formal, non-formal and the "Jua Kali sector". Embracing the "ease of doing business" approach through the UPR for single window returns. Additional mitigations include placement of an automated re-imbursement system to return investment to employers and horizontal and vertical access re-tooling approaches to assure equity extended to all, including PWDs.

4.3 Access to Education in 4th Industrial Revolution

The presentation was made by Mr James Odede, the founder of Lake Hub. The 4th Industrial Revolution shows the blurring link between the physical world, the digital world, and the biological world; i.e., how the digital world will not be any different from the physical world and how it will relate to biology.

The 4IR is paving way for transformative changes in the manner we live and radically disrupting almost every business. The changes are so profound that in human history, there has never been such term of greater promise or potential peril. The technology advances present an opportunity for growth and losses.

Mass education came about during the second industrial revolution to respond to the mass production that was made possible by the invention of electricity since companies and industries needed much labour skills to be used in mass production. The uses of education that were useful a few centuries ago cannot respond to today's societal needs. Computers perform better in tasks that are repetitive, thus threatening most careers. Most careers that are a result of previous education system risk being absolute. Careers such as mechanics are unlikely to stand the test of time due to emergence of electric cars. Kenya's education system ought to be more targeted to address future needs. Despite the milestones already made such as introduction of the competence-based curriculum, these systems still pose a large component of the mass education.

The education system ought to respond to the needs of where the world is headed by integrating lessons such as artificial intelligence, genetic engineering, IoT and blockchain in its curriculum. In the previous settings, Africa was mainly a consumer of technology but, in years to come, a huge part of the workforce of the world will be in Africa. Therefore, there is a challenge in Africa to train a huge number of people to respond to the needs that arise.

One of the ways to respond to the changing needs is targeted education. A recent study reveals that a skill is only valid in a particular field for five years to capture changing needs. Inclusivity is another crucial component as statistics reveal that only 3.5 per cent of Kenyan population have university degrees yet it's the degrees that indicate whether we have gone to school. Therefore, we should look at all areas of the economy and train people that can work in different spaces. Further, the decentralized system also responds to the needs of the 4th industrial revolution, unlike the centralized system which demands individuals to converge in specific locations to acquire skills.

For instance, a course at the University of Nairobi should be available in Turkana. We should aspire to have a demand-based education driven by economic needs, countries aspirations or the continents aspirations. The education system should facilitate learners to have short courses and learn what they need and the same be adopted by the certification system. Equality should also be addressed to ensure that we do not have a large population in the low pay and a few in the high pay, as this will not result to the desired economic transformation.

4.4 The Role of STEM Education in enhancing ST&I

This presentation was delivered by Mr Martin Mungai from the Centre for Mathematics, Science, Technology Education in Africa (CEMASTEA), which was founded in 1998 as a programme for strengthening of mathematics and science secondary education (SMASSE).

The presenter noted that although COVID-19 has disrupted learning, education had not stopped. Particularly, through use of digital platforms, CEMASTEA has continued with development of professional programmes for mathematics and science teachers in the counties. Education and learning can now be seen beyond the brick and wall classroom. Leveraging on Internet technologies to teach and learn has now become the new normal.

CEMASTEA has undertaken specific online trainings focused on inquiry-based-learning (IBL), entrepreneurship, ICT training of teachers on enhancing teachers' competency in integrating ICT in teaching and learning through use of virtual platforms. As an important enabler of the Kenya Vision

2030, STEM education is needed to support development of skills for employment and job creation, guided by needs of different sectors. STEM education is therefore necessary in bridging the gap between opportunities in the labour market and the number of graduates in STEM-related courses.

The presentation indicated that there is need to develop deep and solid understanding of the connection between theoretical knowledge and its application in society through immersion in authentic experimental learning. Indeed, allowing students to experience first-hand the practical application of STEM skills is critical in enhancing their transition into the labour market. STEM skills could enhance the capacity of teachers to innovate new approaches to learning and teaching, with creative problem-solving.

STEM education could support learners determine the need to learn new concepts, help them appreciate concepts, procedures, facts, and principles, provide better explanation of concepts and their application in real-world, and supporting assessment learning against its corresponding. Particularly, the presentation noted that STEM seeks to develop deep mathematical and scientific underpinnings needed by students in preparation for a competitive workforce needed by the 21st century labour market. The competitive workforce should go beyond mere transfer of knowledge, to equipping learners with critical thinking, problem-solving, creative, and collaborative skills, and establishing connections between the school, the workplace, community, and the global economy for enhanced employability. CEMASTEA, through support from the Ministry of Education (MoE), supports schools through provision of equipment, capacity building, and monitoring.

Further, STEM education in Kenya could be promoted through formulation of policies that encourage students to pursue STEM programmes in institutions of learning, linking schools with communities for support, formulating and implementing curriculum in a manner that supports STEM education, ensuring technology is integrated to support curriculum organization and implementation, ensuring physical facilities in schools are adequate, appropriate, and safe in supporting STEM education, and inviting school climate (place, people programme, processes, and policies) to promote STEM education. This way, STEM education could promote problem-solving learning through identification of the problem, exploring information and creating ideas, selecting the best idea, building, and testing the idea, and evaluating the results.

Robotics, for example, engage students in science inquiry and engineering by enabling them to code, create, invent, and explore with digital technologies. These innovations have shifted the traditional role of the teacher as a knowledge transmitter to a learning facilitator, collaborator, and coach, from the primary source of information to knowledge-navigator, and co-learner, from the teacher controlling and directing all aspects of learning to the teacher giving the student more options and responsibilities for their own learning, and from the teacher being stage on the stage to guide on the sides.

In conclusion, there is need for enhanced government support to promote establishment and operationalization of STEM model schools in all counties across Kenya. Training more teachers on STEM skills could further enhance holistic delivery of STEM education to learners while instilling skills on problem identification, information exploration and idea creation, selection of the best idea, building and testing of ideas, and evaluation of results.

4.5 STEM Education on Sustainable Socio-Economic Development

Dr David Njubi from NACOSTI delivered the presentation on the role of STEM education on sustainable socio-economic development.

The presenter noted that Education for sustainable development is an integral element of SDG on quality education and a key enabler of all other SDGs. Indeed, evidence shows that education and the economy are intricately interlinked. Kenya has initiated reforms that seek to improve access to quality education.

The first issue was that inefficiencies in the 8-4-4 education system informed the reform agenda. The education system was flawed and burdensome to learners and teachers on several planes. The latest 2-6-6-3 education curriculum framework is expected to support achievement of the Kenya Vision 2030, whose goals are to help Kenya transform into a middle-income country. Important reforms in education are necessary because they afford a country the opportunity to revisit, revise and appraise its education system and curriculum periodically.

The second issue was the need for Kenya to look at successful models of Competency-Based Curriculum (CBC) from countries that have successful stories implementing CBC and learn from the mistakes and successes. This way, Kenya will have a qualified and competent human resource with relevant skills in ST&I, which will promote realization of a knowledge-based economy and sustainable socio-economic development.

The third issue was the need to incorporate ST&I in development policies and strategies. Realization of the objectives of existing broad policies and strategies such as the SDGs, Africa Agenda 2063, and STISA-2024 are highly dependent on ST&I. Emphasizing training on Science, Technology, Engineering, and Mathematics (STEM) education is important in transforming the Kenyan economy into a knowledge-based economy for sustainable development. The CBC will ensure that the education system is practical, encourages creativity, problem solving, and empowers the youth to take advantage of opportunities presented by ST&I for sustainable development. The education system should further inculcate national values, patriotism, and integrity among the Kenyan youth.

The fourth emerging issues was the role of ST&I in mitigating pandemics such as the COVID-19. Technology allowed epidemiologists and experts around the world to connect, share data, and better predict how quickly the disease spreads and how deadly it is for interventions. Through use of technology, it is possible to disseminate information to citizens on health protocols needed to control a pandemic while supporting remote working. Indeed, most of the problems resulting from the COVID-19 crisis could be mitigated with adequate science literacy. Through use of science, for example, diseases can be categorized as viruses, bacteria, among others. Further, countries have leveraged on emerging technologies such as Big Data, AI and robotics to minimize fatalities related to the COVID-19 pandemic while keeping economies and livelihoods afloat.

The last emerging issue was the need for the Government to continue implementing programmes aimed at nurturing its growing scientific talent pool for wealth creation and expansion of employment opportunities for Kenyan youth. Particularly, the Government, private sector, and the development community should continue investing in science and research to support the achievement of the

aspirations of becoming a prosperous and peaceful nation. This should be supported by rolling out of progressive policies to promote science and innovation as an engine for economic growth and a means of addressing enduring social inequalities.

In conclusion, ST&I is a bedrock upon which the social, political, and economic pillars thrive. To achieve sustainable development, the education sector should provide a globally competitive quality education, training, and research. Further, ICT should be integrated into teaching, learning, and training as critical at all levels of education to support generation and application of knowledge in production processes.

4.6 Panel Discussion: Education

The panel discussion on education and ST& I was chaired by Dr Dinah Samikwa, KIPPRA Board Director. The panelists for the session were Dr Ann Kingiri of African Centre for Technology Studies (ACTS) and Dr Moses Thiga of Kabarak University. The panel discussed policy, institutional and legislative framework in the role of education in ST&I. The key highlights were on competency-based curriculum, capacity building on innovation in universities and funding.

Dr Thiga emphasized that the competency-based curriculum is a sky solution to the impending challenges in the Kenyan education system. He noted that the 8-4-4 education system is memory and knowledge-oriented, especially at the university level, where competency should be a key component of the system. Dr Thiga also noted that the Government had played a key role in research funding. Dr Kingiri emphasized the need for capacity building to support innovation and development through human capital development and the commercialization of research. The Government also supports universities by establishing science parks, innovation hubs, and clusters. However, weak linkages exist between universities and industries/private sectors in promoting innovation. Further, there is inadequate quality research in academia that promotes innovation for sustainable socio-economic development. Among the recommendations given was the need for a paradigm shift in university structures and management to embed the needs of the CBC to cater for the needs of the students that have been introduced to the new curriculum, which is inevitable in the 4th industrial revolution. In addition, the education system needs to establish linkages with the industries for successful implementation of the CBC. In addition, funding in innovation requires capacity building on funding proposal writing, and lastly, there is need for inclusive innovation to promote socio-economic development.

4.7 Presentations from the Break Away Groups

The break-away group on the theme of development of human capital was moderated by Ms Nancy Laibuni (KIPPRA) and had two presentations: Inclusivity of TVET education for mass career growth and development in Kenya; and Levering on technology universities and TVETs students for innovations in green investment and financing for sustainability.

Inclusivity of TVET education for mass career growth and development in Kenya –by Dr Stephen Macharia and Dr David Gichuhi (Karatina University)

The gap identified was that many job seekers lack the requisite skills that employers want. Hence, without employment-related skills, school leavers cannot benefit from even the minimal employment opportunities that may be available to job seekers. This gap can, however, be filled by TVET, whose

primary objective is the facilitation of acquisition of employable skills for the world of work. Some countries have made considerable progress in enhancing the role of TVETs in career growth and development. For example, Austria has 80 per cent of youth in vocational education. For the case of Finland, leadership and innovation is rooted in investment in TVET. For the case of Ghana, TVET is fulfilling human security and has an investment with very high return. For the case of Nigeria, TVET is seen as solving the problem of shortage in skills development. Legislation by itself cannot address problems of perception and attitude that have dogged the curriculum and job opportunities for years. This calls for different stakeholders to get involved.

Utilizing a descriptive research design, and data from the Ministry of Education, Kenya National Examinations Council (KNEC), and TVETA website, the findings indicated that out of the 6,649,937 candidates who sat for KCPE between 2009 and 2016, 1,904,446 candidates or 28.68 per cent of them did not complete secondary education. The highest drop-out rate was 36.96 per cent in 2009 and the lowest was 21.55 per cent in 2016. In addition, out of the 4,745,491 candidates who completed KCSE between 2013 and 2020, 3,770,548 or 79.46 per cent scored grade C plain and below. Those who scored C+ and above were 974,943 or 20.54 percent, with the highest percentage being 34.28 percent in 2010 and the lowest being 11.48 percent in 2013. The conclusion was that majority of graduates at KCPE and KCSE did not get any training for the acquisition of skills, and that TVET was still not absorbing all the KCSE finalists. This meant that the system of education was wasting some of its graduates.

Study recommendations: policy need to be initiated that will make TVET compulsory to those KCSE graduates who do not proceed to university. Education should be compulsory at all levels to completion; there is need to improve on TVET information flow to secondary and primary level of education; there is need of professionalizing more professions such as in transportation, which attracts a lot of youth; and there is need to integrate TVET education in the competency-based education (CBE) from primary school level.

Panel discussion: Ms Nancy Laibuni sought to know the proposals around the certification body, regarding craftsmen and craftswomen who were skilled in their work but lacked formal training, whether they could be considered for certification.

Leveraging on technology universities and TVETs students for innovations in green investments and financing for sustainability –by Dr Francis K. Gitagia (Kenyatta University)

Extreme climatic events can be costly to the economy, generating a loss of about 2.6 per cent of the country's gross domestic product (GDP), based on an estimate by the Kenya National Climate Change Action Plan 2013-2017. These costs could rise to about 7 per cent of GDP by the year 2030. In addition, global warming is increasingly becoming an important policy concern, given that climate change is causing ecological imbalances that may lead to unsustainable development. Green investments have the potential to reduce environmental degradation due to the trade-off that exists between economic development and environmental concerns. Kenya's green investments and innovations are, however, dismal and lag other developed countries. There is therefore need to promote green investments. Despite this recognition, the role of academia and especially institutions of higher learning in sustainable development has not been adequately addressed. Technology universities and TVET institutions need to come up with innovations that address economic, social, and environmental concerns. Furthermore, the connection between Kenya's challenges and opportunities for green growth and the role of financial institutions is not widely recognized.

The findings of the study were as follows: first, on average, university students in Kenyan are not aware of green investment opportunities available in Kenya. Second, there is a significant difference between awareness level of students in technical universities and TVETs compared with those from other institutions. Third, there is a significant difference between males and females in terms of their awareness of green financial investments. Finally, most technical universities and TVET institutions, on average, do have the requisite tools to embrace green investments. Based on the study findings, the study concludes that students in other institutions were more aware of green financial investments than those in technical universities and TVETs. Females were found to be more aware than their male counterparts in green financial investments. Finally, most institutions of higher learning had not embraced science and technology as a key tool to enhance innovations.

The study recommended that the Commission for University Education (CUE) make it compulsory for all programmes to have an environmental component; Technical and Vocational Education and Training Authority (TVETA) should emphasize programmes with environmental component, in its role of accrediting and inspecting programmes and courses; CUE together with university managements need to have more awareness efforts put in place to ensure innovations are undertaken; institutions should put in place efforts for promoting awareness of green financial investments, especially among male students; the Government needs to avail funding to institutes to help them come up with green investments. Universities on their part should also come up with other funding strategies, such as public private partnerships (PPPs) for encouraging innovations; and finally, the Capital Markets Authority (CMA) needs to work in collaboration with the Nairobi Securities Exchange (NSE) to come up with securities that encourage investments in clean and sustainable areas.

4.8 Emerging Issues and Recommendations

Following the presentation and panel discussions, a few issues emerged:

1. Despite disruption of the education calendar and learning due to the COVID-19 pandemic, education beyond the brick and wall classroom and now leveraging on Internet technologies to teach and learn is now becoming the new normal.
2. There are weak linkages between universities and industries/private sectors in promoting innovation.
3. Further, there is inadequate quality research in academia required to promote innovation for sustainable socio-economic development.
4. In skilling the industrial sector, it emerged that there is latency in the integration of the "Jua Kali sector" in the formal assessment and certification system as provided for in the qualifications framework.
5. There is also low absorption by employers in embracing skill upgrading programmes of their staff as new training programmes get developed.
6. Further, there is latency by the industry and other players in technologically advanced units to offer attachment to opportunities to support knowledge transfer and trigger innovation.
7. The industrial sector also faces inadequate innovative, portable, and digitally driven partnerships to ensure that beneficiaries are enabled for decent work, fourth industrial revolution and gig economy.

Recommendations

1. The education sector to continue leveraging on Internet technologies to teach and learn.
2. Strengthening STEAM with continuous development of pedagogical skills of teachers and funding to promote innovation for sustainable socio-economic development.
3. A paradigm shift in university structures and management to embed the need for the CBC to cater for the needs of students that have been introduced to the new curriculum, which is inevitable in the 4th industrial revolution.
4. Establishing linkages with industries will be key for the successful implementation of the CBC.
5. Capacity building on funding proposal writing to support innovation.
6. Need for inclusive innovation to promote socio-economic development.
7. Catalyzed resource mobilization with strategic local, regional and international partners.
8. Priority uptake and implementation of the Recognition of Prior Learning Policy for Qualification awards to the formal, non-formal and the "Jua Kali sector".
9. Embracing the "ease of doing business" approach through the UPR for single window returns. Placement of an automated reimbursement system to return investment to employers
10. Horizontal and vertical access re-tooling approaches to assure equity extended to all including PWDs.

Chapter 5: Building a Strong Innovation System

5.1 Overview

The session on building a strong innovation system discussed the inclusion and participation of PWDs in ST&I and media coverage, investments in research and for quality innovation, technologies and innovation processes, policies and laws on ST&I, patenting and intellectual property rights and innovation systems. The session was moderated by Dr Emmy Chirchir, the Deputy Head of the East Africa Research, and Innovation Hub. Mr Luke Muleka, the founder of Signs Media Ltd, started off the session with a presentation on media coverage of ST&I for PWDs. The session was meant to assess the use of assistive technologies and innovations to help Persons with Disabilities (PWDs) to learn, communicate, or function better. A presentation on the same was made by Mr Eugene Mungai, from the Kilimanjaro Blind Trust Africa. PWDs inclusion in policy formulation processes and innovation systems was covered in this presentation. Mr Sammy Zirolewa, from KIPI, presented on patenting and intellectual property rights. The panel discussions explored the status of the innovation systems in Kenya, challenges and what can be done to promote growth of the system. Prof. Bitange Ndemo, Dr Jaro Arero from UNESCO, Ms Monicah Mueni, Persons with Disability, were members of the panel. Finally, Mr Micheal Ogolla made a presentation on intellectual property rights in the breakaway groups.

5.2 Media Coverage of ST&I for PWDs

The presentation by Luke Muleka began with a brief overview of signs media Kenya. Signs media Kenya have two products, namely, signs language television station called the signs TV and signs language interpretation applications that enables interpreters to access signs language interpretation virtually.

Article 54 of the Constitution mandates that everybody/institutions should not be discriminatory in service delivery irrespective of colour, creed, disability, or any status in life. Signs Media Kenya

took an initiative to ensure that there is inclusion and participatory of PWDs in the space of media communication. Through partnership with the Media Council of Kenya, Signs Media Kenya undertook trainings for PWDs in the field of journalism.

Regarding the media space and ST&I, this is an area they have been grappling with to have the media houses ensure that PWDs are not just being covered or be seen like a fraction of presentation to fulfil a certain mandate from the regulatory authority but to have PWDs involved in formulation of policies around ST&I.

The coverage around innovation and disability is an area that has taken root but is not given enough coverage by the media industry. During the period of COVID-19, deaf people complained about the World Health Organizations (WHO) recommendation for people to wear masks because for them to communicate, they rely on sign language and facial expression that is not possible when masked up.

5.3 Innovation in Assistive Technology

The presentation on innovation in assistive technology was made by Mr Eugene Mungai from the Kilimanjaro Blind Trust Africa. The presenter began by defining assistive technology as any device, software, or equipment that helps Persons with Disabilities (PWDs) to learn, communicate, or function better. He further noted that innovations could change lives by forging new methods of participation, working with communities to harness the value of inventions, innovations and programmes; and that disability innovation has the potential to shape global policy; corporate practice; investment strategies; cultural norms; individual behaviour and life outcomes. He noted that disability innovation is more than a product, service, or policy; rather a way of thinking to address disability challenges by co-designing solutions and sharing knowledge.

Two key issues came out of the presentation. First, more effort is needed in supporting Persons with Disabilities to undertake STEM subjects that broaden their career scopes and towards ST&I. To achieve this, more assistive technologies are required. Secondly, intentional, and joint efforts are required among partners, individuals, organizations and industries to accelerate change through public engagements, consultancy and innovation activities to bring better assistive technologies world over.

Further, the major challenges noted and especially for the visually impaired included: poverty and ignorance around disability and visual impairment resulting in extreme marginalization (e.g. a child with disability is kept at home and blocked from all education hence few possibilities for employment); a blind youth or adult ends up begging or working in a school as a teacher for the blind. The greatest challenge to the visually impaired in East Africa is access to literacy and education, with lack of education being the greatest barrier to social and economic inclusion.

It was recommended that there is need to develop partnerships and programmes to achieve great impact for visually impaired children. Further, ST&I stakeholders need to innovate new approaches and digital technologies through research, training and partnerships.

5.4 Patenting and Intellectual property Rights

Mr Sammy Zirolewa, a Patent Examiner, Pharmaceuticals, at Kenya Industrial Property Institute (KIPI), made a presentation on patenting and intellectual property rights. The presenter begun by giving

a brief highlight of KIPI. Kenya Industrial Property Institute (KIPI) is a government parastatal under the Ministry of Industrialization, Trade and Enterprise Development. The Institute was established on 2nd May 2002 through the Industrial Property Act, 2001. Previously, the Institute existed as Kenya Industrial Property Office (KIPO), which was established in February 1990 after enactment of the Industrial Property Act, CAP 509 of the Laws of Kenya. The functions of the Institute are to administer industrial property rights; provide technological information to the public; promote inventiveness and innovativeness in Kenya; and provide training on industrial property.

The presentation highlighted five types of Intellectual Property Rights (IPRs): a) Patents, b) Utility model, c) Industrial design, d) Trade secret and e) Trademarks. Service mark patents are for products and processes while utility model is for new or improved product or processes. Industrial design is for the aesthetic features (shape and ornamentation) while trade secrets are for undisclosed inventions. Trademark and service marks show goods and services of one trader from those of another. A patent owner has the right to decide who may –or may not –use the patented invention for the period in which the invention is protected. In other words, patent protection means that the invention cannot be commercially made, used, distributed, imported, or sold by others without the patent owner's consent. On enforcements of rights, infringers can be sued for damages, injunctions placed, or jailed.

5.5 Panel Discussion on Innovation Systems

The session was chaired by Dr Emmy Chirchir, Deputy Head of the East Africa Research and Innovation Hub. The panel discussants were Prof. Bitange Ndemo, Dr Jaro Arero from UNESCO, and Ms Monicah Mueni, , a Person Living with Disability.

Prof. Ndemo observed that since independence, ST&I started attracting Government attention in the *Sessional Paper No. 5 of 1992*, when 1 per cent of GDP was allocated towards research and development as a channel for technology transfer and capacity building. In his assessment, Prof. Ndemo noted that Kenya was not investing enough resources towards research and development. Among the challenges facing Kenya with regard to ST&I include poor implementation of policies. Further, he noted that a lot of research has been done in universities, but it is not being operationalized through implementation. Dr Arero observed that low budgetary allocation to research and development was a continental problem, with Africa as a whole investing only around 0.7 per cent of GDP. Further, UNESCO reports show that there is a correlation between research outputs and expenditure on research and development. There is therefore need to enhance human capital through improved budgetary allocation to enhance skills in research and development. Ms Mueni noted that there is need to properly implement the existing policies. On disability, she observed that there is need to bring more partners on board to support dialogue, financial and advocacy on disability issues. She is also noted that, although there is need to patent innovations, more focus should be given towards supporting the youth to come up with new innovations and support implementation of such innovations. Dr Chirchir observed that the overall outcome from the panel session was that Kenya had done well in research and policy formulation, and what is needed more is to focus on implementation of research findings and policies formulated through research-based recommendations.

Prof. Ndemo further observed that there is need for everybody to do their part, with early training on entrepreneurship being incorporated into the education system. Deliberate support to industries by the Government in a collaborative manner through creation of incubation centres and provision of seed capital could provide the much-needed support system. In the Kenyan universities, there are numerous innovations lying there due to lack of a robust support system. There is also need to have a

national dialogue on innovation with keen attention on productivity centres that innovate and create employment. The Government could further protect emerging innovations.

In conclusion, the overarching message rotated around capacity, policies, financing strategies, and political goodwill from the Government. Implementation of the existing policies and research findings is the missing link in the country's development pursuit. Creating targeted incentives to support creation of innovative ideas, incubating the ideas, protecting breakthrough innovations against competition, and facilitating demand for products and services coming from innovations should be a priority for Kenya.

5.6 Presentations from the Break Away Groups

The break-away group on the theme of building robust innovation systems was moderated by Mr Amos Onchiri of National Disaster Management Unit, with one presentation on intellectual property rights laws, innovation, and growth: Evidence from Kenya by Mr Michael Ogolla.

The presentation noted that Kenya, being a member of WTO, is under obligation to meet international property laws such as TRIPS (Trade Related Intellectual Property Rights). The Industrial Property Act of 2001 was established to domesticate international conventions of IPRs such as TRIPS. This Act aims to administer patents and to protect industrial designs and trademarks. Apart from the Industrial Property Act 2001, Kenya enacted the Copyright Act of 2001, which confers exclusive rights to inventors whose works are either registered or not under the Act. The Copyright Board is mandated to implement the Copyright Act. Kenya has also implemented the Counterfeit Act of 2008 to combat counterfeiting in trade. The objective of this study was to examine whether the robust IPR laws that have been implemented in Kenya have led to substantial increase in the number of inventions by small and medium sized enterprises (SMEs). The study compares the number of registered inventions prior and after implementation of these laws to ascertain whether there has been a substantial increase in registered inventions in the country due to IPR laws. Furthermore, the study examined the effect that innovations in the country have had on economic growth. This study applies regression discontinuity in time (RDiT), where time is the running variable. The dataset used was for the period 2000 to 2019.

Based on the available data, patent applications had risen over the years from about 2,000 applications in the year 2000 to 6,000 applications by 2019. There was also growth in industrial designs over the same duration. However, trademarks and utility models had remained relatively constant. However, given the paucity of data, the results section was not complete and more robust results would be availed once the dataset is complete. Mr David Njuguna from KIPI promised to assist the presenter in getting additional data required for the study. The recommendations would be firmed up once the results and dataset required are robust. In the Q&A section, a participant sought to know whether the 1989 Act domesticated the TRIP, which came into effect in 1995. In reply, it was observed that the TRIPS argument was based on other previous arguments, including the Uruguay Round of Negotiations.

5.7 Emerging issues and recommendations

1. Issues around innovation and disabilities are not getting enough media coverage. To overcome this, it is recommended the media and related stakeholders take trainings, adopt use of ST&I and improve the inclusion and participation of PWDs in the industry.

2. The development and implementation of policies sometimes do not consider PWDs. An example of this was when the World Health Organization (WHO) recommended masks for the prevention of the spread of COVID-19 that impeded communication for some of the PWDs, who rely on sign language. Therefore, the inclusion of PWDs in policy making and implementation is vital.

3. It has been observed that PWDs do not get adequate access of educational opportunities, and this impacts on their future by limiting their career choices. The Government needs to develop more programmes aimed at promoting equity for all in education access. This can be done through partnerships and investing in assistive technologies to facilitate ease in learning.

4. The innovation systems in the country still need improvement. Therefore, research, training, partnerships and adoption of new approaches and digital technologies can help promote ST&I.

5. There is a low implementation rate of evidence-based policies currently, and hence the need to increase its uptake. To increase innovations, the Government could offer more incentives to support creation of innovative ideas, incubate the ideas, protect breakthrough innovations against competition, and facilitate demand for products and services coming from innovations.

Chapter 6: Infrastructure in ST&I

6.1 Overview

The session on infrastructure and ST&I was moderated by Mr George Otieno Brian, a broadcast journalist at KTN. The session was meant to address how ST&I can be leveraged to enhance infrastructural development, hence aiding the attainment of the "Big Four" agenda. The session entailed three presentations followed by a panel discussion forum. The presentations were: Deploying Internet of Things (IoT) beyond cities through innovative broadband networks; The opportunity of TV white spaces; Infrastructure development pertaining to PWDs; and Cyber security threats and capacity building to address potential challenges in the implementation of the "Big Four" agenda. The presenters were mainly drawn from academic and research institutions, including I-Lab Africa and civil society for PWDs, and emphasized on building a robust ST& I infrastructure as a driver of economic prosperity and inclusivity.

6.2 Deploying IoT Beyond Cities through Innovative Broadband Networks – The Opportunity of TV White Spaces (TVWS)

Mr Leonard Mabele, Research Fellow, Telecommunications at Strathmore University and Manager at the Internet of Things Research Lab, made a presentation on deploying IoT beyond cities through innovative broadband networks –The TVWS Opportunity. The presentation elicited the imaginations of the possibility of everything being connected to each other to enable provision of services. The basic premise and goal of IoT is to "connect the unconnected." This means that objects that are not currently joined to a computer network, namely the Internet, will be connected so that they can communicate and interact with people and other objects.

Enabling technologies to the Internet of Things include: security privacy; future Internet; knowledge aggregation; standards; nanoelectronics; communication; software; system integration; sensor networks; embedded systems; cloud computing; and discovery services.

IoT is key to supporting the adoption of smart cities in Kenya, considering that rural areas host the biggest fraction of the population. Its value is beyond the cities. Agriculture, off-grid energy use, transportation, and rural healthcare stand out as big blocks for IoT deployment beyond cities.

Some of the running IoT projects include the Transforming Weather Water Data into value-added Information Services for Sustainable Growth in Africa (TWIGA) –A H2020 collaborative project on climate and agriculture data. Additional projects include Low-income Urban Sanitation, a project that uses the MKR Arduino MCU with Sigfox Wisol Chip to monitor sludge levels, and the Disaster Prediction and Management Project, which is a collaborative project with three local universities to monitor flooding patterns for predictive response.

6.3 Infrastructure Development Pertaining to Persons with Disabilities (PWDs)

The presentation on infrastructure development pertaining to PWDs was done by Ms Gloria Njoki, from Deaf Hope (PWD-Hearing). The first issue was defining what PWD entails. Following the UN Convention on the Rights of Persons with Disabilities (UNCRPD), PWD was defined as persons who have long-term physical, mental, intellectual or sensory impairments, which in interaction with various barriers hinders full and effective participation in society on an equal basis with others.

About 2.2 per cent of the Kenyan population live with some form of disability, and majority experienced barriers being mobility, seeing, cognition, hearing, self-care and communication.

Another issue discussed was the key infrastructure to support ST&I development in favour of persons with disabilities (PWDs). Support through financial investment in education for PWDs in primary and secondary schools and TVET, human resource development in STI and disability mainstreaming through awareness, provision of tax incentives for inclusive innovations and technologies, adoption and integration of inclusive technologies and innovations in delivering programmes for PWDs, adoption of inclusive design in policy formulation and implementation, and support linkages, collaboration and partnership, and strengthening supportive physical infrastructure for PWDs could enhance ST&I development.

In conclusion, digital technologies and innovations alone are not a silver bullet and can widen the gaps between persons with and without disabilities if they are not designed to be accessible and inclusive. There is need to deliberately mainstream development of accessible and inclusive digital innovations in public policy through provision of tax incentives. At each of the four stages of the innovation process—challenge identification, prototype design, client testing, and actual production, innovators should make deliberate effort to ensure the final product is accessible, usable, and safe for persons with disabilities (PWDs).

6.4 Cyber Security Threats and Capacity Building to Address Potential Challenge in Implementation of the "Big Four" Agenda

The presentation on cyber security threats and capacity building to address potential challenge in implementation of the "Big Four" agenda was made by Richard Otolo from ILab Africa Research Centre and lead IT Security group at Strathmore University. Ilab Africa plays a key role in capacity building, establishing collaborations and partnerships, academic training, consultancy and outsourcing, research and innovation.

The presenter noted that according to Global Pew Research 2019 poll conducted in 26 countries, cyberattacks are ranked behind only climate change and ISIS as the most feared national threat. The presenter defined data breach as an incident where data is unintentionally exposed to the public. Further, COVID-19 pandemic has accelerated the move to the Internet worldwide, and cybercriminals have taken advantage of this to attack vital digital infrastructure. In essence, cybersecurity aims to preserve integrity, confidentiality, and availability of information. Compromising the areas mentioned above leads to a cybersecurity breach.

Notably, a recent cyber attack occurred on the Colonial Pipeline, which provides the East Coast of the U.S. with nearly half of its gas and jet fuel. The pipeline was recently shuttered for days after ransomware attacks. Colonial Pipeline said it had halted systems for its 5,500 miles of pipeline after being hit by a ransomware hacker. Similarly, in June 2021, the second-largest hospital operator in South Africa was hit by a cyber attack during the COVID-19 outbreak, paralyzing the 6,500-bed private healthcare provider, forcing them to switch to manual backup systems.

To improve cyber security, policy makers must create policies that embed cybersecurity into government initiatives. Additionally, the resources needed to implement these policies should be provided. In improving the resilience to cyber-attack, the country needs to define an incident response plan to be activated in the event of a major attack on her critical infrastructure. The plans should describe immediate nation-wide steps to ensure business continuity even with a sudden loss of computer networks. Notably, Kenya is one of the few countries with a national Cyber Emergency Response Teams (KE-CIRT/CC at CA) that can be strengthened through additional resourcing and collaboration with partners in industry and academia. A comprehensive capacity building framework in Cybersecurity Capacity Maturity Model (CMM) from the Global Cyber Security Capacity Centre (GCSCC) needs to be well planned, adequately resourced, and regularly monitored to achieve better policy and cybersecurity implementation. From the regional experience, Mauritius is the first African country and 14th globally based on the 2018 ITU Global Cybersecurity Index (GCI).

In conclusion like most African countries, Kenya still lacks a dedicated public cybersecurity strategy. As a result, cybersecurity initiatives related to COVID-19 are mostly led by the private sector, especially professional and sectoral federations. Therefore, Kenya must not only demonstrate commitment to cybersecurity but work closely with other key stakeholders to achieve the goal of protecting her citizens, businesses, and organizations.

6.5 Panel Discussion: ST&I Infrastructure

The plenary session was moderated by Mr Brian George Otieno, a broadcast journalist at KTN. Physically present in the plenary was Mr Herbert Alan, a journalist at Signs TV. The panel emphasized on the need for collaborations between the Kenyan Government and KIPPRA as policy makers to establish structures to avert cybercrime. As to what could be done to prevent the occurrence of cyberattacks, the discussants recommended that ST& I has the power to solve world problems of all magnitudes and designs. It was discussed that collaborations and inter-connectedness among Government institutions and the private stakeholders were key in ensuring synergy in transfer of technology and successful implementation of projects. The panel further advocated for more collaborations between the government and private stakeholders through public private partnerships. Lastly, it emerged that there is need for collaboration between Government agencies on ST&I infinitives.

6.6 Emerging Issues and Recommendations

Emerging issues

1. The COVID-19 pandemic has accelerated the move to the Internet worldwide, hence making individuals, institutions and systems vulnerable to cyber criminals.
2. There is an increased tendency to incorporate IoT and artificial intelligence in various activities and industries to enhance efficiency and effectiveness.
3. Digital technologies and innovations alone are not a silver bullet and can widen the gaps between persons with and without disabilities if they are not designed to be accessible and inclusive.

Recommendations

1. To counter cyber insecurity, there is need to enact policies that entrench cybersecurity in Government initiative, improve resilience against cyber attacks, and enhance capacity building.
2. The is need to deliberately mainstream development of accessible and inclusive digital innovations in public policy through provision of tax incentives.
3. There is need for more collaboration between the Government and the private sector through Public Private Partnerships (PPPs) to improve the utilization of existing STI infrastructure in Kenya, and build new infrastructure.
4. The application of technologies such as IoT requires interconnectedness of devices, which is only possible through a strong ST&I infrastructure. The Government requires interventions to develop both human and institutional capacities to catch up with the rapidly evolving technology.

Chapter 7: Cross-Cutting Issues

7.1 Overview

This session on cross-cutting issues covered discussions on: Gender, Persons with Disabilities (PWDs), and youths. The session was chaired by Mr Luke Muleka, the founder and Managing Director of Signs TV. The session discussions highlighted the need for an inclusive approach in ST&I policies and initiatives and advocated for gender equality and youth empowerment in ST&I. Enhancing the availability and affordability of technologies for PWDs through application of ST&I in manufacturing assistive devices for PWDs also informed the debate. The four presentations made in this session covered the following topics: Mainstreaming a gender perspective in ST&I presented by Umulkheir Harun, founder Kesho Alliance Foundation; Gender and ST&I by Jayne Ndenga (PWD); Opportunities for the youth in ST&I by Juliet Owino of Young Scientists Kenya; and Technologies for persons living with disabilities by Peter Kabethi (PWD-Hearing). The panel discussion centred on promoting and enhancing full participation of women, youth, and the disadvantaged in ST&I and increasing access to technologies by PWDs. The presenters and panel discussants were drawn from institutions whose mandate revolves around gender, PWDs and youth from public and private sectors.

7.2 Mainstreaming a Gender Perspective in Science, Technology and Innovation

Ms Umulkheir Harun, Director, Kesho Alliance Foundation, Garissa, made a presentation on mainstreaming a gender perspective in science, technology and innovation. She began by highlighting the key roles of the Foundation, which include: bridging the gender digital fluency gap by creating awareness-role models; establishing community hubs for Internet connectivity; investing in infra-structure-google balloons; and having a department of gender to partner with stakeholders. Further, the presenter noted the important role of institutions and stakeholders in mainstreaming gender

perspectives in STI through accessible learning via TVETs; skilled trainers; incentivizing learning-free courses i.e. Google, Microsoft, CUE to acknowledge online courses equivalent to degrees; ensuring Competence-Based Curriculum (CBC) incorporates ICT; and ensuring competitive and up-to-date courses at universities.

She noted that through the organization, they have had a pilot project in Kuno village, Garissa where they have established Kuno Low Cost Boarding Primary School and have used ST&I for school solutions in filling the gap in access to quality education in the region. They have further provided water and food solutions to ensure sustainability and excellent results.

From the presentation, it was recommended to create a conducive environment to tap into the vast and robust potential in women, for example by strategically positioning women in leadership positions, investing in digital infrastructure in partnership with large corporations such as Microsoft, and upgrade facilities in TVETs in the face of ever-changing technologies.

7.3 Gender and ST&I

A presentation on gender and ST&I was made by Jane Adhiambo Ndenga, a para-athlete in professional wheelchair tennis and power-lifting. She is trained on Sexual Reproductive Health Rights (SRHR). On the importance of gender balance in science, technology and innovation, the presenter highlighted the need to optimize women's participation in ST&I for civic obligation for equality of all citizens. A gender-balanced workforce has the benefit of having a wider and enriching range of perspectives, which leads to more innovative problem-solving and decision-making capacities. Gender balance allows increased human resources from women, hence boosts the country's economic status. Gender balance permits voicing of opinions without discrimination and effective planning in families and communities. It also aids in reducing the gender gap.

Among the gender barriers influencing participation in science, technology and innovation include gender roles, norms and perceptions by the society of capabilities of either gender. Stereotypes of men being better at ST&I or being more likely to succeed exist. There are also cultural barriers preventing women from accessing science, technological and innovative opportunities. Additional barriers include lack of attention to address women's needs.

The policy areas to consider for improved participation of either gender includes mainstreaming gender equity in science and technology education. There is need to remove obstacles to women in science and make science responsive to the needs of society and also make science and technology decision-making process more "gender aware". Policy should address ethical issues in science and technology and also call for collection of gender disaggregated data. The presenter called for gender mainstreaming in STI policy making. In addition, there is need to understand gender differences in terms of access to resources and opportunities, a recognition of the abilities and innovative capacities at the grassroots level, and building capacities of people to access, create and implement solutions. It involves applying the gender lens in each phase of the policy making process, and in particular: a) at the research level, evidence-based assessments of problems and challenges that take into account gender equality, and gendered gaps in design and implementation of STI policies and strategies; b) at the design level, where there is need for problem-based solutions and strategies elaborated in consultation with women at all levels; c) at the implementation and monitoring level, programmes and support structures to implement gender-responsive STI policy, such as credit and financing, scaling up, and expert advisory support. Also needed is capacity-building in supporting institutions through partnerships, consultation and training with and for women to ensure the development of new or enhanced local-scale technologies, which are appropriate to conditions, users, and problems.

The presentation also highlighted various assistive technologies for persons with disabilities (PWDs). These include mobility aids such as wheelchairs, scooters, walkers, canes, crutches, prosthetic devices, and orthotic devices. Hearing aids help people hear or hear more clearly while cognitive aids, including computer or electrical assistive devices, help people with memory, attention, or other challenges in their thinking skills. Computer software and hardware, such as voice recognition programmes, screen readers, and screen enlargement applications, help people with mobility and sensory impairments use computers and mobile devices. Further, tools such as automatic page turners, book holders, and adapted pencil grips help learners with disabilities participate in educational activities. Closed captioning allows people with hearing problems to watch movies, television programmes, and other digital media. Physical modifications in the built environment, including ramps, grab bars, and wider doorways enable access to buildings, businesses, and workplaces. Others are lightweight, high-performance mobility devices that enable persons with disabilities to play sports and be physically active. In addition, adaptive switches and utensils allow those with limited motor skills to eat, play games, and accomplish other activities. Others are devices and features of devices to help perform tasks such as cooking, dressing, and grooming; specialized handles and grips, devices that extend reach, and lights on telephones and doorbells.

7.4 Opportunities for the Youth in ST&I

The presentation was delivered by Juliet Owino from the National Youth Council (NYC), a state corporation in the Ministry of ICT, Innovation, and Youth Affairs. The first issue touched on the available opportunities for youth in ST&I. The "Big Four" agenda provides the youth with opportunities for self-actualization, economic empowerment, and dignified living. The Youth Enable Programme has been rolled out to create youth agropreneurs through skills acquisition and creating an enabling environment in which the youth become owners of profitable agribusinesses through youth agribusiness incubation centres, job creation, food security, and improved livelihoods for the youth in rural and urban areas.

The *Ajira Digital Programme* offers ST&I skills in design and content creation, administration and customer service, accounting, web, mobile, and software development, sales and marketing, data science and analytics, IT and networking, and writing and translation. This programme has succeeded in training the youth on how to exploit opportunities in the digital marketplace.

Another issue discussed was on funds available to support the youth to exploit opportunities in ST&I. The Youth Enterprise Development Fund (YEDF) is an example of a fund that encourages the youth to be job creators and not just job-seekers. It provides financial and business development support services. Uwezo Fund is another fund that seeks to support women, youth, and PWDs to access finances to eradicate extreme poverty and hunger and promote gender equality and empower women.

The Kenya Youth Employment Opportunities Project (KYEOP) also supports the youth by empowering and uplifting the well-being of the youth in Kenya. It has projects such as Mbele na Biz, Business Grants, and Training and Internships. The SME Support Centre further provides business advisory to SMEs and supports in the mobilization of investment capital.

In conclusion, there is need to provide incentives on direct technical assistance and training to growth-oriented manufacturing SMEs owned by the youth. TVET programmes that provide graduates with opportunities for practical learning should be prioritized in the budget-making cycle as they play an important role in instilling ST&I skills among the youth.

7.5 Technologies for Persons Living with Disabilities

The presentation on technologies for persons living with disabilities was made by Mr Peter Kabethi. The discussion focused on the latest technologies and innovations for the deaf. The presenter defined a deaf person as someone who cannot perceive sound. Hard hearing refers to an individual who has residual hearing and with/without amplification while pre-lingual are born or become deaf before language development and post-lingual became deaf after language development. The presenter noted that the commonly used technologies for the deaf include assertive, restorative and access.

The assertive technology comprises Assistive Listening Devices (ALDs), assists to amplify the sounds that one wants to hear, especially where there is a lot of background noise. ALDs are also used with a hearing aid or cochlear implant to help a wearer hear certain sounds better. Augmentative and alternative communication (AAC) devices are part of assertive technology that helps people with communication disorders to express themselves. These devices range from a simple picture board to a computer programme that synthesizes speech from text to alerting devices that connect to a doorbell, telephone, or alarm that emits a loud sound or blinking light to let someone with hearing loss know that an event is taking place.

Restorative technology restores lost function fully/partially; for instance, hearing aids and cochlear implants. The presenter noted that using the technologies is not on restoring function but on achieving an end goal by whatever means possible through text messaging, video phones, and captions. Augmentative technologies are comprised of SMS, Emails, instant messaging, captioned telephone, closed captioning and open captioning (always on the screen like subtitles of a foreign film).

Access technologies include speech captions, which include: Auto-synchronization; Speech + transcript captions and computer-aided Realtime transcription. The other access technology is Speech-to-text. Transcription is mainly supported by platforms such as Windows Dictation; Window's Speech Recognition; Dragon Professional Individual; Google Docs Voice Typing; NaturalReader, among others. Video and web access technologies include Video remote interpreting; Signing avatars; Apps such as SRHR sign language, Deaf elimuPlus, Deaf BIBLE and Digital educational content (signed)-e Kitabu. Other technologies used include alerting devices such as doorbell light; phone ringer light; fire alarm light; baby monitor light or vibrator, alarm clock light or vibrator.

The presenter noted that technologies for the deaf have evolved over the past years with the latest technology being a smart glass that translates voice and text into sign language appearing on the lenses in real time. Also, wearable tech glove translates sign language into speech in real time. However, not much has been done by innovators to develop and avail affordable, portable, accessible websites and technology that can assist deaf and PWDs in general so that they can be included in the implementation of the "Big Four" agenda.

7.6 ST&I Data and Statistics

7.6.1 Availability and use of ST&I data and statistics

The presentation on ST&I and data was made by Mr Abdukadir Amin, the Director of Population and Statistics at the Kenya National Bureau of Statistics. The Bureau is the custodian of all statistics in the country and is thus required to provide statistical information to the Government to monitor and evaluate its ability to provide basic, economic social and other rights to its citizens.

Mr Amin reported that the Bureau has been collecting ST&I statistics, which is published in several publications such as the economic surveys. Between 2007 and 2012, the Ministry of ICT in collaboration with KNBS generated the ST&I indicators with the support of NEPAD. The indicators were mapped based on various sectors such as agriculture, forestry, fishing, insurance, mining and quarrying, among others. The most common indicators of ST&I include R&D, innovation, patent, collaborations between university and industry. Most of this data is available in data open platforms provided by international institutions.

The innovation survey of 2012 and research and development survey of 2019 are the only main sources of ST&I data. ST&I indicators provide essential statistical data for both formulation of public policies and investment in R&D. The Bureau tracks the performance of ST&I indicators in the annual economic survey. This is tracked through mechanisms such as research licenses issued, application and licenses granted by nationality, individual research licenses granted and research category per gender. The presenter emphasized that the Bureau was experiencing deficit in statistics of ST&I for both formal and informal sector, which was useful for sound decision making.

7.6.2 Role of Data Protection in ST&I Sector

The role of data protection in ST&I sector was presented by Ms Immaculate Kassait, Data commissioner. She began by highlighting the mandate of the Office of Data Commissioner as derived from the Data Protection Act, 2019 and includes: Regulating the processing of personal data; Ensuring that the processing of personal data is guided by the principles set out in section 25 of the Act; Protecting the privacy of individuals; Establishing the legal and institutional mechanism to protect personal data; and providing data subjects with rights and remedies to protect their personal data from processing that is not in accordance with the Act.

Regarding the role of data protection in ST&I, she noted that application of the Data Protection Principles will result in: Increased transparency and good governance; Economic growth; Enhanced investor confidence; Assessment of risks through the Data Protection Impact Assessment (DPIA); Safeguarding of personal data; and Correct application or data use will unlock opportunities.

Other policy considerations include: Promote the education and awareness of data protection rights and the ethical and legal uses of personal data. This will ensure better solutions for socio-economic development that are founded on trust, and support the core principles of data protection.

7.6.3 Panel Discussion: ST&I Data and Statistics

The panel discussion on ST&I data and statistics was moderated by Mr Nzomo Mbithuka, Board Member, Kenya Institute for Public Policy Research and Analysis. The panellists included Dr Humphrey Njogu (KIPPRA), Anne Gitonga (KIPPRA), and Nora Ndege (Research Fellow, African Centre for Technology Studies).

Dr Njogu responded to the question regarding ST&I data sensitivity and the country's preparedness to handle data by first stating that the Data Protection Act was enacted in 2019 and the appointment of the first data commissioner done in 2020. The panelist highlighted that KIPPRA is participating in the process of developing the data protection regulations meant to effect/guide the implementation of the Act. Regarding how the Act related to ST&I, the Act allows researchers to process personal data while adhering to the data protection principles. Personal data can be categorized into sensitive

(such as health data, sexual orientation of a person) and non-sensitive personal data. While the Act allows research to use personal data, researchers have to ensure that personal data cannot be used to re-identify someone. Regarding how the Act is supporting furthering of Data Science, Big Data, and Artificial Intelligence, the Act is very progressive in that it supports ST&I. The Act is not strict on emerging technologies and developing product solutions provided they adhere to the general principles of handling personal data. Globally, privacy has become so critical in this digital age. At the continent level, Kenya is ranked top in the Internet economy. Data protection creates more confidence with investors in terms of protecting personal data as is currently demanded. The Act is also generating employment opportunities. For instance, entities are expected to recruit data protection officers who would oversee personal data in those entities, and therefore the Act is a game changer in recent times. Regarding the status of statistics on ST&I, Ms Anne Gitonga pointed out that institutions are big users of data from KNBS. She highlighted that KNBS receives data from relevant stakeholders. Data on ST&I is, however, still very limited despite its importance in guiding policy implementation and policy design. Data is also important in benchmarking. Other than KNBS, ST&I statistics can be available from innovation surveys and the African Innovation Outlook. Kenyan industrial base is micro and small, and majority of the enterprises are informal. Of all the enterprises that innovate, half are informal where informal refers to not registered. It is difficult to get statistics that relate to such enterprises given that they are not readily available in known forums, hence the need for the current policy debate.

A follow up question on whether Government agencies must always wait for structured data to come to them or there are possibilities for the Government to plug in unstructured data platforms and use that for planning and spur innovation. The panellist concurred that indeed Government can leverage on other avenues, other than the structured platforms to obtain data and statistics. For instance, the 2012 MSME Act establishes an MSME registrar, and the mandate of the registrar should form what is needed to be documented from MSMs. There is also need to strengthen networks that are not necessarily individual institutions that would be of benefit to the country. For instance, in Brazil and India, associations are well governed and supported by the Government and are potential opportunities to obtain information from the ground that would otherwise be unavailable.

The panel discussion also focused on the relevance of Big Data towards the "Big Four" Development Agenda and what can be done to stimulate growth and development within the STI sector. Ms Nora Ndege, a Research Fellow at the African Centre for Technology Studies, pointed out that Big Data is more about scale and is characterized by: Volume; Value; and Variety of data in terms of diversity. Big Data requires innovate ways of data mining. Further, she acknowledged the central role of Big Data for the 4th industrial revolution. There is need to ensure we have the capacity around Big Data within in terms of skills to process, the technology needed to process the data, skills to foresight. Big data will help inform planning and how to achieve the aspirations such as the Big Four. There is thus a good opportunity to leverage on technology, but as a country we need to put in place the necessary infrastructure when it comes to supporting skills. There is also need to grasp the latest data available and thus the need to develop capacity to use Big data and update it. Further, there is need for a centralized location for collecting data and updating it. This will solve issues of fragmented data held at various agencies.

Regarding our readiness to exploit Big Data, the discussions revealed that indicators point a bright future for the country. From a policy, legal, and capability point of view, the country has what it takes to have what the future is presenting. For instance, the country has a Digital Economy Blueprint that is clear on the pillars that need to be concentrated on. For instance, several Government services are offered on digital platform, though we are still behind compared to the developed countries. Among the barriers is the digital gap where the Internet is quite expensive. E-Commerce is coming up well

and Kenya is ranked number, despite various challenges. For instance, Kenya lacks a comprehensive E-Commerce policy and legal framework. Therefore, while a lot more can be done, the future is bright in terms of reaping the benefits of digital economy.

The country needs to address some of the policy gaps to incentivize the private sector to undertake more R&D, policy interventions that strengthen opportunities to introduce innovate products and how to strengthen the whole ecosystem, acknowledging the several players whose interactions are unique and distinct.

7.7 Panel Discussion: Cross-Cutting Issues

The panel discussion on cross-cutting issues discussed the following: To understand the status of Kenyan health systems; to know the gaps in Kenya's policy, regulatory and Institutional frameworks regarding health systems, and what needs to be done to strengthen the health systems in Kenya.

Health is a devolved function. The National Government oversees the policies and the County Governments govern service delivery. About 8,000 hospitals are under the NHIF scheme. The big debate currently is on universal health coverage. UHC is one of the SDG goals and it is about providing affordable and accessible health care to all citizens. Countries need to consider the pillars of UHC and uniqueness of a country on what needs to be done in the provision of UHC.

7.8 Emerging Issues and Recommendations

The emerging issues that came out are: Changing economic, social, demographic and societal needs require new data sets to aid analysis to inform timely and accurate interventions to emerging issues such as COVID-19. High burden of expenditure in health systems emanating mainly from financial risks and growing demand for healthcare in the country. There is need for investment in health management and in R&D. Concerns were raised on limited application of simple technologies in prevention of infectious and respiratory diseases. There is need to enhance the application of ST&I in health service delivery. Digital innovations are improving the lives of deaf and hard hearing people. However, invented technologies for the deaf are deemed unaffordable for the deaf community in Kenya.

From the panel discussions, the proposed solutions include:

1. Need for awareness to enhance understanding of gender differences in terms of access to resources and opportunities, recognition of the abilities and innovative capacities at the grassroots level, and building capacities of people to access, create and implement ST&I solutions.
1. Stakeholders from the public, private and development sectors to collaborate and undertake continuous investment in R&D as a way to address gaps in STI data.
2. Gender should be mainstreamed in public policy to address gender differentiated barriers influencing participation in Science, Technology, and Innovation (ST&I) opportunities including gender roles, norms and perceptions by the society of capabilities of either gender.
3. Innovators in Kenya need to develop and avail portable, accessible websites real-time technologies to foster inclusion for the deaf and PWDs in implementing the development agenda.

Chapter 8: Building Resilience

8.1 Overview

The theme on building resilience with ST&I aimed at appreciating the roles of agricultural technologies, food security and nutrition, water, sanitation and waste management, blue economy and technology, sustainable cities and communities and disaster preparedness and the role of ST&I. This session took place on the third day of the Conference and there were three plenary sessions; that is, building resilience, agriculture, and industrialization &STI. The specific presentations that were made included: Status of disaster preparedness in Kenya; Research and impact on COVID-19 pandemic; Building strong innovation systems; Panel discussion on building resilience; Presentations from the break-away groups on building resilience; Health; Agriculture; and Panel discussion on agriculture. The plenary sessions were moderated by Dr Duncan Ochieng', National Disaster Management Unit; Ms Linda Musumba, KIPPRA Board Chair; Mr Saresh Patel, KAM; and Dr Humphrey Njogu, KIPPRA.

8.2 Status of Disaster Preparedness in Kenya

A presentation on the status of disaster preparedness in Kenya was done by Dr Duncan Ochieng', Director of the National Disaster Management Unit (NDMU). The NDMU was established in 2013, through a presidential directive, and is mandated to provide overall leadership, command and control of disaster management efforts in Kenya. The Unit is also responsible for: capacity building of all personnel in ministries, departments and agencies; monitoring and evaluation of disaster risk reduction; programmes and activities and carrying out research in emergency and disaster management.

The presentation touched on the research and impact of the COVID-19 pandemic and the building of strong innovative systems. Disaster Risk Management (DRM) is cyclic in nature and comprises of four major phases: prevention/mitigation, preparedness, response and recovery. There has been a general shift from disaster response to disaster risk reduction as heavily enshrined in the Sendai framework

for Disaster Risk Reduction 2015-2030. Therefore, focus needs to be on reduction of existing risks and prevention of new risks. This necessitates policy makers to look at the risk in the social and economic activities and understanding the linkages between human behaviour and vulnerability to disaster risks.

The Biblical teachings of Noah building an Ark to shelter from the coming floods is an example of disaster preparedness. The Government has made tremendous effort in disaster preparedness, whose expected outcome is the substantial reduction of disaster risks and losses in lives, environmental, social and economic assets of our communities. Since independence in 1963, Kenya has faced the challenge of how to properly manage the recurring and new disaster risks due to inconsistency in disaster risk governance, which includes the lack of a harmonized legislative policy and institutional framework in disaster risk management. This has seen the country operate under a fragmented disaster risk reduction architecture. Currently, Kenya has various agencies that deal with management of disasters in the country that include NDMU (provides overall leadership), the National Disaster Operation Centre (in-charge of resource mobilization and emergence response), the National Drought Management Authority and other disaster management entities in the Ministry of Health, the Kenya Defence Forces, the Kenya Medical Department, NuPEA, Kenya Nuclear Regulatory Agency, the Directorate of Peace Building in the Ministry of Interior, among others. However, the trend of having hazard-specific institutions is not good for the nation and for disaster management. Therefore, solid evidence is needed to negate this trend of having hazard-specific institutions and channel disaster risk management conversations towards evidence-based policies. The call for harmonization of DRM policies, legislative and institutional frameworks is therefore valid. This will strengthen disaster risk governance, and there after enhance disaster preparedness.

In conclusion, for Kenya to effectively and efficiently manage disasters, the public sector's preparedness and response is vital. Rather than entities acting in silos, mechanisms are required to coordinate and offer strategic direction on disaster management, especially during the preparedness phase. Thus, there is an urgent need to streamline disaster risk management in Kenya through legislative and institutional frameworks that will harmonize the many disaster management silos and strengthen disaster preparedness for effective response and recovery. Secondly, while we recognize the NMDU's leading and coordinating role in disaster management, both National and County Governments need to engage with the relevant stakeholders, including women, children, the youth and PWDs in the design and implementation of policies, plans and standards to ensure due consideration of the end users. Thirdly, the public and private sector, including civil societies, academia, scientific and research institutions need to work more closely and create opportunities for collaboration. Businesses need to integrate disaster risk management into their operations and management systems. Lastly, integration of ST&I into disaster risk management is important as there is a serious correlation between the two, and development.

8.3 Building Strong Innovation Systems

The presentation on building strong innovation systems: A case study of Kenya Revenue Authority was made by Ms Gladys Kitony from Kenya Revenue Authority. The presentation highlighted three innovation thematic areas including innovations to improve customer service aimed at improving customer interactions; innovation to ensure that there is tax space expansion; and process innovations aimed at reengineering internal processes to ensure efficiency.

The presenter noted that innovations borrowed from best practices from public institutions are necessary to foster efficiency. Apart from KRA's core systems, the discussion continued with key

highlights on technological innovations that have been implemented in the recent past, for example, the regional electronic cargo tracking system used to tackle transit diversion; the ISCAN system used to enhance scanning to detect concealment and tackling tax evasion, and the IKNOW platforms to enhance knowledge exchange, among others.

The presentation also highlighted the impact of innovation on tax and customer administration, including increased innovation culture measured annually, improved processes leading to increased efficiency, increased customer satisfaction, and cost-saving.

In conclusion, the presenter pointed out the need for public sector organizations to embrace innovations and work with internal and external stakeholders in the innovation processes because it is the only thing to improve the delivery of services to customers/ clients. On the way forward, the presenter indicated that KRA is innovating in areas of customer service and constant customer complaints are minimized, process of innovations ensures that service delivery is efficient.

8.4 Panel Discussion: Building Resilience

This panel session was moderated by Dr Duncan Ochieng' (NDMA) who was also a panellist. The discussion was based on building resilience, the panellists in this session shared their thoughts related to building disaster risk management. Mr Fred Majiwa from St Johns' Ambulance noted that Kenya has made strides towards improving their resilience and preparedness in disaster risk management. However, there is need to have legislation and provision of funds that will assist in disaster management in the counties. At the National Government, the panellist mentioned that there is need for stakeholders to enhance national coordination in disaster risk management forums.

The panellist deliberated on the status of disaster preparedness in Kenya and whether the function has been fully devolved. Dr Duncan Ochieng' responded to this question by mentioning that issues of disaster preparedness in Kenya are a shared responsibility by National Government and County Government. County Governments under the 2010 Constitution of Kenya have been empowered to carry out certain activities to ensure the community they live in is safe; counties are allocated 2 per cent on their national budget to deal with disaster management, though in terms of responses there is certain levels that requires intervention of National Government, especially when the resources of a County Government are not adequate to deal with the prevailing disaster. The country still faces challenges in disaster risk management because the DRM Act has not been put in place, but some counties have come up DRM Act with the help of the Senate, and they are able to legislate on the fire hazards and other risks that may be experienced their counties. Some of the current challenges identified are: the framework for prudent utilization of disaster management funds is not in place; there is no existing of legislation to guide DRM in the country; and that there lacks an effective strategy to manage disasters in the country.

In conclusion, it was noted that for Kenya to effectively and efficiently manage disasters situation that threatens the country development, a whole public and private sector preparedness and response is necessary and vital. Rather than the affected entities acting with the best intention in isolation and taking action unilaterally ,a mechanism is required to coordinate policy and strategic direction, on disaster risk management in Kenya and more so preparedness in the country in addition there is urgent need to streamlined disaster risk management in Kenya through proper legislative, institutional framework that will harmonize the many disaster management silos and strengthened disaster preparedness for effective response and preparedness. While recognizing leading regulatory and coordination role

both National and County Government should engage with relevant stakeholders, including women, children, youth and persons with disabilities, technical volunteers in the design and implementation of policy, plans and standards. There is need for public and private sector, civil society, academia, scientific and research institutions to work closely and to create opportunities for collaboration and business to integrate disaster risk management in their management practices. Lastly, organizations could consider integrating science technology and innovations into disaster risk management, having in mind there is a serious correlation between disaster and development.

8.5 Presentations from the Break Away Groups - Building Resilience

Various presentations were made under the theme of building resilience with ST&I. The session was chaired by Ms Nancy Laibuni. Foremost, Mr George Ruheni's presentation was a study on science, technology and innovations, and public policy and resilience in development in Kenya. The overall goal of undertaking this study is to provide policy makers with insight on the policies that can be fundamental catalysts in designing and creating an enabling environment for robust economy. This study highlights the value chain concept and what it entails. An exploratory approach is used in this study as the authors explore relevant literature on food security and nutrition, water, sanitation and waste management, blue economy, healthcare, housing development, fintech and e-commerce.

Efficiency in production and consumption of goods and services can be improved using ST&Is such as fintech and e-commerce. Recycle, reuse, remanufacture and reduce in a cyclic economy has proven to be efficient and effective in resource utilization. This can be applied in the waste management, extractives and water sectors. The adoption of a cyclic economy reduces Green House Gas (GHG) emissions, deforestation, soil degradation and water depletion as there will be a decrease in extractive activities. Therefore, the growing environmental and climate change concerns will be addressed. The costs of production and waste quantities also go down. Better environmental and climatic conditions will boost food security, which will in turn cause an improvement in healthcare. This is in line with the Government's universal health care agenda. Policies that promote and implement public health and home-based care need to be promoted, developed and implemented as they are more effective and pocket friendly. The blue economy improves on food security and the micro and macro economies. Food security will also increase employment opportunities and reduce poverty levels due to increased productivity, produce and opportunities along the value chain. The improvement of livelihoods will lead to more tax revenue, investments in affordable decent housing, peace, adequate delivery of services and stronger resilience in development. These services include: electricity, roads, water, sanitation and waste management. Collaboration of various stakeholders who include governments, private sector, civil society and donors would bridge the affordable housing gap. Good rural urban planning and accruing incentives would promote building of factories in rural areas, eliminating urban sprawl and discourage urban bias. These policies would promote affordable houses and mitigate uncontrolled urbanization. Progressive, agile and research guided policies are fundamental for resilience in community development. In conclusion, the adoption of a cyclic economy, pro-poor policies, proper urban planning, utilization of the blue economy and the use of ST&I in production can help in the achievement of the Kenya Vision 2030, improve livelihoods, foster resilience in development and address climate change concerns.

The second presentation was on understanding the link between resilience and economic systems by Mr Salim Seif Kombo. The presenter highlighted that the issue of fragility and resilience is useful for financial institutions to help identify how different pillars of fragility such as the social, political,

environmental, and economic pillars are all integrated, which can at times be unpredictable. The framework is helpful to financial institutions in understanding the different indicators of resilience, which helps utilize how well the client base can be able to adopt to shocks and how disruptive it can be from business continuity.

Financial institutions are very key in building resilience in fragile contexts at both the community and national level. Through their ability to mobilize resources, they can drive growth; they can help to mitigate risks and create opportunities for job creation. However, working in fragile context can be quite challenging and presents different risks and uncertainties that can adversely affect the organization wishing to work in these areas and they can be faced with an anticipated consequences to the communities that are targeted, which can potentially further fragility.

The key findings identified from presentations include: First, that financial institutions need to be more intentional about designing and delivering financial solutions that have a dual function of supporting development and resilience outcomes in fragile contexts. This requires them to have a long-term view in the fragile contexts they are working in. Second, that diagnostic assessments of fragile contexts should be conducted to identify the financial products and services that build resilience capacities (absorptive, adaptive, transformative) that financial solutions can and should support. These assessments should identify the key resilience capacities that people in these contexts require, the impact that the shocks are having, and the business case for delivering a financial product/ service that can alleviate the impact of the shock. Third, adopting an inter-pillar approach to develop a package of financial solutions that are mutually supportive is key in supporting key resilience capacities in a fragile context. Financial services and products that can build resilience across multiple dimensions of fragility (e.g. social, environmental, and economic) can help build more resilient countries and communities, which are less vulnerable to shocks. Fourth, that the financial solutions offered do not inadvertently undermine the resilience of people in fragile contexts by supporting non-resilient development approaches.

The key recommendations identified by the presenter were that financial institutions need flexibility in responding to emerging challenges and opportunities that may arise. A useful framework to enable this is an adaptive management approach. This approach should encourage financial institutions to continuously learn, prototype, iterate and adapt their products and services in the face of changing contextual and risk factors to ensure maximum impact and sustainability

The study on Chemical, Biological, Radiological and Nuclear Risk Management in Kenya was presented by Dr Duncan Ochieng, Austine Aluoch, Ali Gakweli and Amos Ayieni. The study pointed out that Chemical, Biological, Radiological and Nuclear (CBRN) agents are unique due to their dual nature, which means they find use in both domestic and industrial and as Weapons of Mass Destruction (WMD). The threat and risk posed by CBRN materials could not be ignored at the period when COVID-19 pandemic has presented systemic risks that are crippling economies around the world. It is against this background that this study was undertaken through a descriptive survey.

The findings revealed that several efforts have been made, such as the establishment of various institutions to manage disasters including: the National Disaster Management Unit in 2013; National Disaster Operation Centre established in 1998 after the El Nino rains to offer coordination and/or serve as the national Emergency Operations Centre (EOC) is also alive; the Government Chemist Department (GCD) under the Ministry of Interior and Coordination of National Government; Kenya Nuclear Regulatory Authority (KeNRA); The Nuclear Power Energy Agency (NuPEA) which is envisioned as a platform for steering clear the realization of Nuclear Power Plant (NPP) in Kenya, Energy Act (2020); the

National Commission for Science, Technology and Innovation is the National Focal Point for Biological and Toxins Weapons Convention (BWC) providing leadership in its implementation.

The study established that milestones have been made through the following areas of capacity building through various programmes offered by the National Disaster Management Unit in collaboration with the Government Chemist Department between 2016 and 2021 where 931,597 and 462 participants have been trained in Nairobi, Mombasa and Kisumu, respectively, targeting Government institutions, industry and the informal sector on various areas of disaster management. Data collected during the survey indicated that there are five key threats posed by CBRN: terrorist organizations, non-state political groups, individuals, accidental releases and natural exposure. In this regard, there is need to explore engineering and policy solutions to enhance CBRN disaster preparedness.

The study established the overlapping institutional mandates. The three key institutions charged with the responsibility of disaster risk management and the two established by Acts of Parliament on the area of radiological and nuclear safety and security, create a competing rather than complementing disaster risk management platform. Another major gap is lack of awareness on the CBRN threat, safety and security in CBRN risk management.

In conclusion, CBRN threats include nation-states; terrorist organizations; non-state political groups; individuals; accidental releases from biological research or diagnostic laboratories, or chemical industry facilities. The complexity of these threats is high, with transnational threats from actors and CBRN materials, extreme weather causing CBRN incidents, and human error. The study proposed the policy makers to conduct adequate research and development for appropriate austerity measures. There is unending need for information sharing on the CBRN safety and security, and joint research needs to be developed with regard to mitigating CBRN threats through technological approaches.

Beatrice Kinyua presented a paper on leveraging on digitalization to boost export-based manufacturing in Kenya. The presentation began by noting that manufacturing is outlined in Kenya's "Big Four" agenda as one of the four transformative sectors aimed at creating 2 million more jobs by 2022 while increasing the sector's GDP share contribution to 15 percent. Regional trade has great potential in enhancing Kenya's industrial capabilities as most manufactured exports are destined to developing countries, especially in Africa. Studies have shown that adoption of digitalization has been proven to reduce the overall production costs by 90 per cent while facilitating regional integration, hence its vitality as a cost saving mechanism especially in this period of the COVID-19 menace. Unfortunately, Kenya's overall exports of goods and services as a percentage of GDP have been declining over the years from 20 per cent in 2013 to 12 per cent in 2019. More profoundly, the share of manufactured exports to the total merchandise exports was 31 per cent in 2019 compared to the world's average of 68 per cent within the same period. Additionally, the share of manufacturing value added has been on a declining trend from 12.79 per cent in 2012 to 7.54 per cent in 2019 indicating de-industrialization.

In contrast, the presentation noted that Kenya has been ranked third in Sub-Saharan Africa under the Global Innovation Index due to its digital capabilities and regional dominance in Internet connectivity, mobile money services and ICT development. 95 per cent of Kenya's manufactured exports are mostly of low and medium-low technology intensities, with only 4.6 per cent of exports comprising high technology intensity. To assess whether digitalization boosts Kenya's export-based manufacturing, the presenter adopted panel data gravity model and applied the Poisson Pseudo Maximum Likelihood (PPML) using data on exports from the top major trading partners. The analysis covered the period 2013 to 2018. Digitalization is measured using indicators from the World Bank Global Innovation Index

(GII) combined into a composite index (DigiIndex) examined by the Principal Component Analysis (PCA) and included in the gravity model as an independent variable.

The key findings were that digitalization was highly significant, indicating that its adoption would boost export-based manufacturing in Kenya by 138 per cent. Other variables that were found to be significant in the study were GDP and exchange of Kenya's trading partners, which had a positive effect on export-based manufacturing. Distance between the trading nation's capital cities and membership to a regional trade agreement were significant but had a negative effect on manufactured exports. Trade openness had no significant effect.

8.6 Health

8.6.1 Role of ST&I on Health care - Keynote

The Keynote speech was delivered by Dr Nzioki Charles, the Director Health Policy Research, Monitoring and Evaluation in the Ministry of Health on behalf of Hon. Mutahi Kagwe, EGH CS, Ministry of Health. The Key highlights from the speech are highlighted below.

The Kenya health sector strategic plan 2018-2023 outlines a clear plan whose vision is to transform health systems with the aim of achieving universal healthcare. To achieve this, R&D is one of the key investment areas among the eight investment areas proposed in the document. The Ministry has developed a research for health policy framework 2018-2030, which provides guidance on how the national research for health ecosystem shall align to the Science, Technology and Innovation Act 2013, National Health Act 2017, Kenya Vision 2030, and the Kenyan Constitution 2010. The research for health questions that need urgent attention are addressed in the research for health priority documents, which highlight the priority areas where the available finances should be allocated to solve more urgent issues in health research. The review is undertaken after every three years.

KEMRI engages in research in collaboration with other stakeholders, both local and international. KEMRI recently undertook its annual scientific conference where different presenters demonstrated innovations to enhance service delivery, and the work is being currently synthesized to identify best practices. Innovation has enabled seamless availability of services such as HIV testing at home using the various self-test kits available. ST&I has been holistically used to support the management of COVID-19. Various technological innovations are also being sourced from the local community through local manufacture hand-washing machines. Strategic collaborations are also crucial in initiatives such as testing of local vaccines. The R&D component has been facilitated through infrastructural development to facilitate projects such as vaccine development for COVID-19 and other infectious diseases. For the financial year 2020/2021, the Ministry has allocated health research Ksh 2.8 billion. In the eight-point stimulus package, the President committed to allocating more resources to fund innovation in the field of medical research.

8.6.2 Impact of Technology on Health Care

Dr Cecilia Wanjala, Deputy Director, Commercial Enterprises at Kenya Medical Research Institute presented on impact of technology on healthcare. Looking at technological innovation, the presenter noted that innovation is greater than invention. Innovation relies on new knowledge that is developed on a technological basis. Development may be led by disruptive discoveries or incremental changes

caused by competitive pressure or customer needs. Innovation is usually expressed as the Big Idea/ Great Invention. But much innovation in practice is rather mundane and incremental rather than radical. Looking at healthcare services, it is important to appreciate that healthcare provision is complex and ambiguous because human beings are the main objects in the health care system. And in these complex systems, measuring performance in healthcare context is not easy. Nevertheless, healthcare relies heavily on technological development.

Some of the technological innovations in healthcare delivery include medical equipment; devices; new pharmaceuticals; diagnostics; clinical procedures; organizational and support systems e.g. databases; measures of prevention and rehabilitation of diseases; and measures of prevention and rehabilitation of diseases. KEMRI cannot be left behind in the talk about impact of technology on healthcare. KEMRI is the medical research arm of the Government and provides advice to the Ministry on various aspects of healthcare and delivery. Its vision is to be a leading centre of excellence in research for human health. Its mission is to improve human health and quality of life through research, capacity building, innovation and service delivery.

KEMRI has research centres spread throughout the country. The Institute collaborates with various stakeholders, both local and international, in the health care delivery system. The Institute has a department that looks at research output commercialization. The Institute has successfully rolled out products from its research work. A good example is the hand sanitizer for hand hygiene. Other products include decontaminants mainly stabilized sodium hypochlorite and enzyme-based cleaner for surgical equipment; rapid diagnostics kits including Hepatitis B, HIV, Rift valley fever kits. Malaria and COVID 19 antigen kits are under development; and a Virus Transport Media (VTM) where the capacity was upscaled and supplied to laboratories during COVID-19 emergency period.

Some of the services offered by KEMRI include clinical laboratory diagnostic services; rapid emergency response and disease surveillance (COVID -9 testing and Ebola), and genetic testing (paternity tests). The Institute also has a deworming programme where over 6 million school age children from 28 counties in Western, Nyanza, Rift Valley and Coast regions are dewormed annually since 2012 by KEMRI, MoE and MoH. KEMRI is monitoring the impact of treatment in 200 schools from 16 counties in these regions. Additional services include ethical review for protocols and cancer registry.

The major achievements the Institute has had in the country include the national diseases surveillance and rapid response capacity for major disease outbreaks (COVID-19 pandemic, cholera, chikungunya virus, H1N1 flu, Yellow Fever, Rift Valley Fever, Ebola, aflatoxicosis, etc). The other major achievement has been the successful hand hygiene and decontaminants' product development and commercialization. The Institute has also developed new treatment for leishmaniasis and is involved in research that led to the current anti-Tuberculosis treatment. In addition, the Institute is involved in the malaria vaccine that the country is about to roll out (pilot). KEMRI also currently plays a leading role in the National Human Vaccine Manufacturing Initiative, and finally the Institute houses the National Cancer Registry.

8.6.3 Panel discussion on health systems

The panel discussion on health systems was moderated by Dr Humphrey Njogu, Kenya Institute for Public Policy Research and Analysis. The panelists included Prof. Anselimo Makokha, AMREF International University, representing Dr Gitahi Githinji, AMREF Kenya; Dr Josiah Rono, E&K Consulting; and Ms Yeddah Machage, Snr Assistant Manager, Public Health and Communications, NHIF, Nairobi Region. The discussions centred on three key areas: the status of Kenyan health systems; the gaps in

Kenya's policy, institutional and regulatory framework, and what could be done to strengthen health systems in Kenya.

The three panelists responded on the above issues as follows:

Ms Yeddah Machage: She began by noting that the governance of health systems is devolved at the two levels of government, National Government and County Government levels. The role of the Ministry of Health is to oversee government policies while County Governments oversee service delivery. She highlighted the UHC framework, which encompasses the pillars of legal, governance, and financing policy. Further, the UHC framework recognizes that the context of each country is unique – it is not about the model that will be sufficient for a given activity; what is important is achieving the health care needs of the citizens. Therefore, NHIF is the primary instrument for delivering healthcare in Kenya and has a network of over 8,000 hospitals from level 1 to level 6.

The gaps in health care systems were highlighted as well, and include quality of health care services and especially the primary health care which is not offered across the 47 counties; quality of health care given is not consistent with good medical practices in all the counties; thus the need for a consistent policy framework for ensuring quality service delivery. Moreover, it was noted that Kenyans are being exposed to health care risks and catastrophic expenditure; that is, spending beyond their income levels on health-related issues.

The second panelist, Prof. Anselem Magoha noted the following: there are gaps in application of technology and innovation in health care systems. For instance, during the COVID-19 pandemic, use of simple technologies such as handwashing has led to significant reduction in diseases. Ordinarily, we rarely use such simple methods in our day-to-day lives despite their importance. This should be enforced even in post-COVID-19 era. Further, application of ICT is critical to address the pandemic, yet the social media is full of fake news. This can potentially affect the uptake of vaccines, which are critical interventions for COVID-19 pandemic and prevention of other diseases. There is therefore need to prioritize strengthening of ICT in delivery of health care outcomes.

The third panelist, Dr Josiah Rono provided the following perspective: There is disproportionate burden of prevalence of diseases in Kenya, hence the need to invest more in health care. He noted that the fiscal space for health care is limited, as only 2.1 percent of Kenya's GDP is spent on health care, which is less than the 5 per cent required to achieve Universal Health Coverage. Further, he noted the need to invest at least 2 per cent of Kenya's GDP on research and development, and that 30 per cent of that overall research budget should be allocated to health research. Additionally, he observed the need to prioritize on investment on health care. He pointed out that the rate of return on health care interventions is significant. For example, every one (1) Kenya shilling invested in health care brings about ten (10) Kenya shillings in the economy. This provides a strong case to invest in healthcare where you could get tenfold returns.

8.7 Agriculture

8.7.1 Role of ST&I in agriculture sector growth and transformation

Ms Naomi Njeri read the speech on behalf of the Principal Secretary, ***Prof. Hamadi Iddi Boga of State Department for Crops Development and Agricultural Research***. The key highlights from the speech: Development of agriculture sector plays an important part in ensuring food and nutrition, security

for the country, embracing new technologies in the production and supply systems in the sector can hasten the achievement of food and nutrition security for all as emphasized in the "Big Four" agenda. The agriculture sector transformation and growth strategy is supposed to run from 2019 to 2029. It will provide an approach that can lead to food and nutrition, security, and recognizes the importance of technology in agriculture to achieve food and nutrition security for all the Ministry targets to put more emphasis on promotion of informed of innovations and technologies.

Technology is a broad term, meaning collection of techniques and processes in the production of goods. The application of technology targets, the four dimensions of food and nutrition security that is affordability, access, utilization and stability technologies for improvement of food availability. The country is currently implementing a wide range of technologies to improve affordability of food, key among them is promotion of access to affordable farm inputs in partnership with Safaricom development of a management system geared towards reaching over 200,000 higher need farmers and adoption of E-Locust application to locate movement of locusts for the purpose of mitigating their effects on food security. Further, technology can help provide affordable, balanced food choices to follow up population. This can be done through improved crop varieties or improved nutrition.

The stability of food and nutrition security is currently at a threat due to climate change that has led to erratic weather pattern that has distorted the farming calendar and led to frequent drought, floods, emergence of new pests, among others. To address this, the Ministry is promoting use of climate-match technologies. To achieve high technological skills, we must invest in our people to develop the expertise needed in different nodes of the food and to continuously address the dynamics that keep on emerging in food and nutrition.

The ministry has initiated policy reforms whose objective is to promote technology adoption in agriculture. It has initiated national agriculture mechanization bill to improve agriculture mechanization in the sector, which is currently below 30 percent.

8.7.2 Agricultural technologies and food security

The presentation on agricultural technologies and food security was made by Dr Christian Tiambo from International Livestock Research Institute (ILRI). ILRI is a non-profit institution that helps people in low- and middle-income countries to improve their livelihoods and lands though animals, which remains the backbone of small-scale agriculture and enterprise across the developing world. ILRI belongs to Consultative Group on International Agricultural Research (CGIAR), a global research-for-development partnership working for a food-secure future.

Food security "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The pillars of food and nutrition security are: availability, access, stability and utilization. To achieve food and nutrition security, four areas can be prioritized for action: increase investment in agriculture; broaden access to food; improve governance of global trade; and increase productivity and conserve natural resources. The New Partnership for Africa's Development (NEPAD) has created the African Biosciences Initiative (ABI) that aims at improving agriculture and livelihoods with centres spread across Africa. Animal and Forest Biotech programmess under the ABI are in Eastern and Central Africa, respectively. ILRI's solutions for food and nutrition security are embedded in capacity building communications, knowledge management, livestock genetics and animal and human health. Livestock genetics improves genetics for better productivity and profitability. This is being done through

sustainable livestock systems and feed and forage development. Animal and human health delivers solutions for livestock, zoonotic and foodborne diseases. This is being implemented through BecA-ILRI hub, impact at scale and policies, institutions and livelihoods (including gender). ILRI has research strategies on technologies for food security and nutrition in the areas of: information management, matching breeds to ecology/environment, breeding information and decision marking in breeding, genomic selection and genomic merit, application and utilization of markers and accelerated and sustained genetic gains.

The African Dairy Genetic Gains (ADGG) and the African Chicken Genetic Gains (ACGG) are two of ILRI's farmer-facing programmes that have incorporated technology to improve efficiency. The goal of ADGG is to bridge the gaps between the amounts of milk produced by farmers practicing at different scales, thereby increasing efficiency and profitability. ADGG uses smart applications of Genomics and ICT through public-private partneships (PPPs). ACGG has a platform for testing, delivering, and improving chickens for enhanced livelihood outcomes. The programme aims to provide a pathway out of poverty and equitable improvement of livelihoods by providing income, employment and nutrition. ACGG uses innovation platforms for developing solutions across the value chain, armer preferred breeds of chickens, PPPs, high-producing genetics well-adapted to low-input production systems and is centred on women. The results are remarkable, with chicken gaining 200-300 per cent body weight, egg production increasing by 100-160 per cent and having 9 improved breeds. There are also efforts to revive rare chicken, made possible by indigenous chicken biobanking to support local poultry industry. In relation to this, there has been capacity building for indigenous chicken genetic resources preservation and a drive for bio-banked material to better livestock productivity, food and nutrition security. Successful genetic improvements result into improvements of agronomic performances and diseases control. Improved resilience leads to efficient growth, improved fertility, better quality of produce such as meat and eggs, increased profitability, sustainability and vaccines. ILRI's animal and human health approach to food security and nutrition entails technological and institutional innovations and generating evidence and developing solutions to improve food safety. The approach is risk-based with a framework consisting of risk management, risk assessment and risk communication.

Application of biotechnology in Sub-Saharan Africa is still low. This is due to challenges such as: inadequate resources to develop and safely apply biotechnology (human, infrastructure and funding) and inadequate policies and legal frameworks (biosafety, IPR, strategies). For there to be a conducive environment for a sustainable agribiotech in Kenya, several actions need to be taken. These include: implementation of proactive polices and biosafety regulation, legislation, policies and institutions; scientific capacity building; protect and encourage private investments; public awareness and acceptance and resources and partnerships.

In conclusion, to improve on food security, policy makers can: learn from the One Health approach; make agriculture more attractive; invest in agribiotech capacity building, research and development; and build bridges between knowledge producers and end users.

8.7.3 Technologies on scaling up nutrition

Edgar Onyango from Scaling Up Nutrition Civil Society Alliance presented on technologies on scaling up nutrition. The presenter highlighted delineated digital health as the application of information and communication technologies and data that can be generated to support the making of informed decisions by health systems, with the motive of increasing demand to access affordable and available health services.

There are forms of digital health that are available on a global scale that include: E-health, medical informatics, health informatics, telemedicine, telehealth, mHealth, data analytics, big data, and artificial intelligence. The presenter pointed out that the availability of these applications depends on the transition of technology in Kenya and globally. In accordance with this, statistics show the penetration of smart phones in Kenya is at 80 per cent and 50 per cent of these are smart phones while 30 percent are basic phones. Sim card penetration is above 100 per cent, since most people have more than one sim card. This means that the most vulnerable can be reached daily through their cell phones.

Digital health interventions address several challenges common to health systems, such as gaps in information and services, availability of commodities and quality services. The presenter underscored the fact that Kenya has 46 health digital solutions with 9 located in Nairobi at community, Primary Health Care (PHC) levels and hospitals. These tools assess and monitor growth, and are used in treatment, counseling, referral and counter-referral of patients and follow-ups.

Finally, the presenter highlighted the key tools that measure child growth that are currently in use in Kenya. They include mobile applications for digitizing, standardizing and streamlining the work of community health workers, monitoring child growth and supervising health care workers. The major advantage of mobile applications that the tools improve calculation and interpretation of growth charts, registration of patients, providing counseling, data entry and consolidating data. A major problem experienced with mobile applications is based on health workers who may use phones set aside for this purpose for personal interests, which may affect the security of data and confidential information. A second key tool currently in use in the country is Anthroimaging. This tool uses 3-D technology to measure a child's height, head and arm circumference. Its main benefit is its portability and affordability, while its major challenge falls within the scanning and processing software, which needs further development due to the rapidly growing technology. Another key tool used is the Digital Height Board. This board is like current height boards, but the output is digital. The benefit of this tool is evident in its digital output, which reduces errors and transfers data electronically to a cell phone. A major drawback faced with this tool is its cost, which is twice as much as the price of a regular height board. The other tool highlighted in the presentation was the M-health, which is a phone used to capture data. This tool incorporates the use of speed in the collection of data, ensures accuracy of information and is familiar and convenient to its users and is affordable. The main setback is data security since it can be stolen or accessed improperly if stored on a device, and the other setback is rapid change in technology.

8.7.4 Blue economy and technology

Dr Jonathan Munguti, Director of Aquaculture, Kenya Marine and Fisheries Research Institute (KMFRI) on behalf of the Director General, Prof. James Njiru, did a presentation on blue economy and technology. The adapted working definition for sustainable blue economy suggests that it emerges when economic activity is in balance with the long-term capacity of ocean ecosystems to support activities and remain resilient and healthy. In Kenya, the ocean and water space covers about 770km square from the shores to the ocean, with 600km sq running from Somali to Tanzania. The inland waters cover 10,700km square, making the total water space equivalent to total land surface are of 31 out of 47 counties. There is approximately three-quarter space which can be developed in the ocean.

The concept of blue economy goes beyond the sector. It entails common practices such as deep sea fishing, aquaculture, sport fishing and artisanal fishing. Other areas for future exploitation include deep sea mining, wind energy and luxury tourism. In responding to challenges and threats KMFRI also ventures in piracy and illegal fishing, though they lack capacity to monitor activities in the deep waters.

Blue economy is crucial to the Kenyan economy since it drives strategic focus on national ocean resources for economic development. Efforts to optimize the gains in Kenya's Blue economy should be geared towards the key sectors, namely:

1. Fishing industry: There is a disparity between its potential and the actual fish production capacity. The Kenya exclusive economic zone has an annual potential of 350,000 metric tonnes equivalent to Ksh 90 billion but only yields a paltry of 9,134 metric tonnes worth Ksh 2.9 billion.
2. Sport fishing/Tourism: Malindi is the only place in the world that offers fantasy slam by catching 5 different billfish species (broadbill, swordfish, black, blue and striped marlin and sailfish in one day.
3. Aquaculture-seaweed cultivation: Kenya is a net importer of seaweed. 15 sites along the Kenyan coast have been identified as suitable for harvesting seaweeds.
4. High end tourism areas: One cruise ship landing in Mombasa has a high potential of carrying 400 tourists compared to those arriving by air.
5. Resource areas e.g boat/ship building has the potential of creating employment especially for the youth.

To ensure proper exploitation of ocean resources, there is need to enhance safety and security to protect marine resources and activities by developing the necessary legal framework and roll out a maritime law enforcement. In addition, attractive fiscal and regulatory environment is essential in encouraging investments in areas such as local ship building, repair and maintenance; registration of ships in Kenyan register and discouraging export of maritime services (insurance, container cleaning and repair).

Currently, the immediate and profitable opportunities in maritime industry lie in fishing, water transport, bunkering, ship building logistics, oil and gas, dry docking and ship services. As the sector seeks to grow by maximizing on the opportunities and potential for the current and future generations, right interventions need to be put in place to enhance maritime investments and value for resources. There is need to provide leadership and visibility for maritime education and training by encouraging university programmes in marine affairs, coastal engineering, port and harbour management and planning. Poor information on the range possibilities and career availability has also been a major drawback. Therefore, leveraging on media to create awareness on the activities of blue economy and providing career education information regarding employment is necessary.

8.8 Panel Discussion - Agriculture

The panel discussion on agriculture was Chaired by the KIPPRA Board Chair, Dr Linda Musumba and it consisted of the following speakers: Mr Joseph Kimote from the National Cereals and Produce Board, Ms Helen Mware from KEPHIS and Prof. Dominic Mwenja from Miramar International. The panel discussion touched on: the role of ST&I in the agriculture sector, growth, and transformation; appropriate agricultural technologies towards building effective and efficient research and development support systems; the role played by both public and private sector in supporting the implementation of new agriculture technologies; the missing link in adoption of agricultural technologies; the policy gaps that require intervention in the use of ST&I in the agriculture sector; the affordability of hydroponics farming; and opportunities for further research in the innovations in the agriculture sector.

Mr Kimote opened the panel discussion by talking on food availability, security, government initiatives and the application of ST&I. He stated that food availability in this country has been affected dramatically because of the decreasing arable land and water resources, including other ecological and agronomic factors. Adoption of technologies for appropriate transport and storage can help minimize food losses and wastage of food by retailers and consumers. Small scale farmers encounter market access challenges. Therefore, use of storage facilities, post-harvest technologies and low power refrigeration mechanisms are encouraged to minimize food post-harvest losses and mismanagement. Examples of agriculture technologies include early warning system, with timely alerts to avert losses caused by extreme weather events and the biofortification, which is a breeding of micronutrients that ensures that we have an effective approach of combative malnutrition, especially in developing countries. About 98 per cent of Kenya's agriculture is rain-fed and therefore highly susceptible to climate change and variability. Innovative mechanisms are therefore necessary to ensure food security. The agriculture sector is a source for employment opportunities and income generation (both foreign and domestic). Because of agriculture's importance to the economy, the government is working hard on improving food systems infrastructure and innovations and investing in human capacity, focusing on small scale farmers. There is need for coming up in mechanisms to channel and incubate innovation ideas from farmers. The Government needs to help with protection and patenting agricultural innovations and intellectual properties. The food systems need to be designed to be pro-poor and support the marginalized communities.

Ms Mware spoke on the Government's role and innovations in enhancing service delivery and ST&I use through the Ministry of Agriculture. The Kenya Plant Health Inspectorate Service (KEPHIS) supports those who wish to import or export any plant material or plant, including the fruits and vegetables. KEPHIS is also involved in seed certification. The improvement of available seed varieties is one of the agricultural areas with more innovations. KEPHIS ensures that seed varieties are beneficial to farmers by inspecting imports, ensure suitability of seeds varieties to agricultural zones and collaborations with agriculture research institutions such as KALRO, and other international research institutions registration for registration. KEPHIS innovations include an electronic platform that ensures that the seed certification is seamless with inspections carried out in the field and during imports or exports. They have a web-based electronic certification system (ECS), which is an electronic automated system for phytosanitary certification for exports, launched in April 2011. A Plant Important Quarantine Regulatory System (PIQRS), which is an automated system for import certification was launched in March 2015. The Kenya National Electronic Single Window System (KENSWS) and Seed Certification and Plant Variety Protection (SC&PVP) system are also innovations, which was launched in December 2020. KEPHIS also has innovated laboratory protocols that support inspection services such as the Muguga laboratory (COMESA reference lab) and the ACL laboratory (EU and Africa reference lab). KALRO undertakes research, comes up with plenty of innovations, offers capacity building and awareness to the public. KALRO and KEPHIS have platforms through which locally and internationally developed technologies are available to farmers.

Prof. Dominic Mwenja explained what Miramar International does in matters agriculture. They explore innovative ways to improve productivity and farming using hydroponic science, aquaponics, and aquaculture, focus on the youth. ST&I in important in their mission. Hydroponic science enables growth of food basically anywhere, any place, any time, provided there is water. The science allows one to build technology around the science that enables them to grow more food per square meter. The science also allows one to grow food that hardly uses the chemicals used in the conventional food production, because it uses biofungicides and biopesticides that allow one to grow food that is safe. They also look at specialization along the supply and production value chains that have the potential of multiple job creation. A combined effort approach to funding, training and production in the agricultural sector can

help elevate the sector to benefit the economy. An online speaker, Dr Peter Chege, said that he prefers hydroponic farming because of the limited farmland availability. The high cost of energy, irrigation and need of electricity are some of the reasons for the low adoption of hydroponics in Africa. The use of ST&I has enhanced efficiency in farming, with the number of hydroponic farms in Africa and East Africa on the rise.

8.9 Presentations from the Break Away Groups - Agriculture

For the Break Away Group on food security and nutrition, Prof. Lokuruk Michael delivered the presentation *on* resilience building for food and nutrition security in Kenya's arid and semi-arid lands—a potential strategy for the "Big Four" agenda.

In the presentation, Prof. Lokuruk, observed that arid and semi-arid lands make up approximately 89 per cent of Kenya's land mass, have over 70 per cent of its livestock assets and about 38 per cent of the country's population. Focusing on 9 of the 23 ASAL counties—Turkana, Marsabit, Isiolo, Garissa, Samburu, Mandera, Wajir, Baringo and Tana River, the presenter noted that annual rainfall in the arid areas is between 150 and 550 mm and in the semi-arid areas between 550 and 850 mm per year. Temperatures are high throughout the year, with high rates of evapo-transpiration. Rainfall patterns are erratic in both amount and timing. These counties are also most likely to be negatively affected by climate change manifestations. The small-scale farmers commonly practice rain-dependent subsistence agriculture on small plots on the banks of the seasonal rivers in the counties. The amount of traditional land under food production is insignificant, despite the potential for greater production using rain-fed and irrigated-agriculture. Due to its aridity, the region bears the brunt of food and nutrition insecurity and a proportionately higher percentage of its population often faces starvation, whenever droughts occur. Malnutrition and the rate of stunting and wasting in the region's children are quite high.

The presentation pointed towards a need to reduce food and nutrition insecurity in these counties. Past efforts to reduce the perennial food and nutrition insecurity have failed due to lack of long-term commitment from the national level of Government, the continued use of inefficient and inappropriate farming technologies, low level of mechanization, and over-emphasis on maize for the staple cereal crop. The high poverty indices, low and unpredictable amount of rainfall for rain-fed agriculture, low levels of education of the able-bodied, poor livestock marketing systems of poor-quality stock, high crop production costs, high food prices, low livestock prices and low per capita incomes of the majority of the counties' residents are also major contributors to food and nutrition insecurity situation of the region.

To improve food and nutrition security, it is recommended that the national government cedes the implementation of food production programmes to County Governments, while it strengthens food production policies and supports resilience-building. By the National Government extending conditional grants to counties to meet planned food production targets and taking a keen interest in the attainment of food and nutrition security, more locally grown food can be realized. Employment by counties of adequate numbers of food scientists, agriculturists, energy engineers, water engineers and people trained in other relevant disciplines is required to provide the appropriate advice, build resilience in the farming community through extension services and training to enable adequate food production, the application of appropriate food handling techniques and marketing.

Improvements in farming technologies, water harvesting, and natural energy harnessing are needed. Currently, the inefficient hoe for both tiling the land and weeding is the main tool for the farmer,

while seed is sown by hand. Due to the high intensity of sunshine in these counties, the potential for harnessing solar energy for food production, processing and food preservation theoretically exists. Concerted efforts to increase the use of natural energy sources can lead to innovations in solar and wind-powered machines for sowing seed, ploughing and weeding, food processing and preservation. The improvements in production are capable of placing more land under agriculture. Improvements in water storage and pumping with wind and solar-powered equipment and delivery devices for watering crops can also be explored. These improvements should eventually reduce dependence on food importation, which raises food prices. These efforts can incentivize local farmers. The likely innovations can also enable Governments achieve higher targets under the "food security item" in the "Big Four" agenda.

The attainment of the Sustainable Development Goals number 1 and 2–ending poverty and hunger by achieving food security, improved nutrition and promoting sustainable agriculture is realizable. By raising the employment rate of the able-bodied, skilled and the educated, improving market access and prices of livestock to benefit the herders and the potential for higher per capita incomes, progressive reduction of food and nutrition insecurity can be secured. Efficient use of available farmland by County Governments, emphasis on low-water demand, short-maturing, salt-tolerant and drought-tolerant crops, the application of appropriate technologies and science in food production, value addition, preservation and marketing, diversification of livelihoods, and close cooperation between the two levels of government, are likely to improve the availability of affordable food of the appropriate quantity and quality. The potential result is a win-win situation for both levels of government and the residents of the arid counties, who are perennially faced with the prospect of starvation.

The other presentation on food security was presented by Mr Patrick Ogutu and Wilson Ojenge. The study title was "Chicken Banda Chick's Banda Using Fuzzy Logic Technique for Ensuring Sufficient Food Supply".

According to the study, temperature and humidity environmental control is used in nearly each and every field of application such as domestic set up, industries, research work and other many areas. The paper illustrates a mathematical model of a chicken chicks' Banda temperature and humidity control using neural Fuzzy logic control. Based on practical data taken in the laboratory set up, a transfer function model of the chicken chicks' Banda.

The paper was an experimental analysis of automatic chicken chicks' Banda temperature and humidity controller, which uses the environmental conditions to measure and control the cage humidity and temperature. A mathematical model of the system is developed, a prototype humidity and temperature controller using Arduino/display unit is designed and MATLAB simulation of neuro fuzzy logic to analyze the behaviour. The results depict that the temperature and humidity varies between 29°C to 32°C and 45 to 48 per cent, respectively. The response of the prototype is able to act with energy saving of 3800J in 200 seconds. The issue of high cost incurred in energy consumption is addressed, hence contribution to sustainable food and nutritional security by ensuring huge supply of healthy chicks using less energy and power. The energy cost was studied and it resulted into great savings with remarkable improvement in efficiency. The optimum performance of the chicken Banda is realized.

The energy efficient system was examined and findings revealed that the energy efficiency was 95 per cent, which shows a remarkable improvement in efficiency hence the optimum performance of the chicken chick. The Banda system resulted into the following benefits: an energy efficient system and food security with healthy chick's, hence sufficient food supply. The paper highly contributed to the theme "Harnessing ST&I for resilience development: Focusing on food security and nutrition

The paper on Identification of community-based organizations in integrated land and water management: Case study of Tende- Kibuon river catchment, Kenya ,was presented by Dymphina Andima. The study indicated that Kibuon and Tende rivers drain areas of 760 km^2 and 780 km^2, respectively, in the districts of Kisii, Rachuonyo, Nyamira and Homa Bay in Nyanza Province into the Winam Gulf on eastern bank of the Lake Victoria in Kenya.

The number of CBOs in the catchment has been below that required by the Integrated Land and Water Management project to effectively implement project activities. The current situation is that there exists only registered self-help groups that operate on merry-round basis and identify with their own groups.

In identifying existing and creating new community-based organizations, persons with disability are among the vulnerable groups but their participation is not well documented due to cultural barriers that exist in families, the community and at the household levels.

The objective of the study was to develop an inventory of existing self-help groups and community-based organizations (CBOs) to organize meetings of the self-help groups and CBOs for familiarization to train and sensitize the self-help groups on requirements for CBO formation for the watershed management project activities before registration. To sensitize and train the CBOs in group dynamics.

The findings of the study included: A total of 87 CBOs have officials in place and have bank accounts and have been trained on groups dynamics, wrote proposals for funding based on the specific projects of their choice. Secondly, proposals have been vetted and approved for funding. Third, proposal activities highlighted include: Reduction of eucalyptus trees and their removal along water courses, rehabilitation of gullies, construction/rehabilitation of spring sheds and water pans, reclamation, and rehabilitation of wetlands. Lastly, the mobilization of communities into organized grassroot CBOs and trainings in group dynamics, watershed management technologies and proposal writing resulted in high expectations from the project, which might not be met fully and community members outside the project blocks who did not attend any of the meetings or trainings are submitting proposals for funding despite the fact that they do not understand the project objectives and conditions for funding community sub-projects.

In conclusion, the participation of CBOs in the project helped in addressing the various land and water management areas. The project reached a higher number of farmers across the blocks and skills and knowledge imparted to the group has potential for utilization of proper management of their groups during the project. Future areas of intervention include taking into account issues of ST&I by inclusion of vulnerable groups such as the disabled, elderly in future projects since farmers have technologies.

8.10 Housing

8.10.1 The role of ST&I in affordable housing in Kenya

The presentation on the role of ST&I in affordable housing was made by Mr Patrick Bucha, MBS Housing Secretary, State Department for Housing and Urban Development. The presentation focused on the existing legal, policy, and institutional frameworks on housing, description of housing as a fundamental human right, progress made, challenges and the way forward. The provision of affordable housing is one of the critical pillars of the "Big Four" agenda and is identified as key in implementing the social pillar of the Kenya Vision 2030. The presenter noted that the concept of affordable housing is not new

and was put forward in the Theory of Rights, which considers housing as 2nd generation group of rights coming only after the 1st generation of rights, which includes a variety of freedoms. Similarly, the importance of housing is recognized under the Universal Declaration of Human Rights (1948) where everyone has a right to adequate living standards for health and well-being, including housing.

Notably, a more recently defined strategy is the New Urban Agenda (NUA) of 2016, providing for sustainable urbanization and the development of inclusive, safe, resilient, and sustainable cities and human settlements. The Sustainable Development Goals (SDGs) Goal 11.1 target also advocates for access to adequate, safe, and affordable housing and basic services and upgrading slums by 2030. Further, the Constitution of Kenya Article 43 (1) (b) recognizes the right to accessible and adequate housing and reasonable sanitation standards. The presenter indicated that access to affordable housing is critical as the majority of the population in the country spend more than 40 per cent of their income on rent, well above the recommended 30 per cent with the cheapest home built in 2012 cost of US$ 15,000, which is more than ten times the average annual income of US$ 1,340.

The presenter mentioned that the Affordable Housing Programme (AHP) incorporates aspects of supply, demand, and enabling environment to ensure a seamless implementation of the project. On the supply side, the programme has a demand master plan and takes a megacity approach, mixed-use developments to ensure inclusivity, and the provision of social infrastructure and amenities. Affordable financing mechanisms for the developers have been put in place through demonstration of aggregated demand on *Boma Yangu*. The enablers for the project include the provision of land and bulk infrastructure, which is also supported by Kenya Urban Support Programme (KUSP) tax incentives and tax breaks (zero ratings of Stamp duty for first-time homeowners); standardized designs and processes, and legal and policy review and amendments. To encourage the uptake of the housing units, the programme offers the tenant purchase schemes, affordable mortgages through our local banks, KMRC (extending mortgage tenures) and housing portal to assist in identifying the end buyer.

The presenter highlighted that the AHP has an impact on the broader economy beyond the delivery with an estimated contribution of real estate and construction from the current 7 per cent to 14 per cent by 2022. He also pointed out that labour has the potential to capture 10.5 per cent by the value spending in affordable housing. In addition, the formalization of the informal sector by ring-fencing will ensure that the Jua Kali sector is capacitated to supply inputs to the affordable housing program and light industries could provide construction materials such as cement.

Despite the challenges faced, the key milestones achieved include establishing the Boma Yangu portal with voluntary contributions standing at over Ksh 600 million. Similarly, the park road project 1,370 affordable units are complete, and allocation is ongoing. AHP in Shauri Moyo, Starehe, and Athi Smart City is in the project pipeline and expected to kick off soon. Despite the notable progress made by the National Government in the provision of affordable housing, County Governments also have a key role to play in provision of affordable housing as counties own vast land for new development and re-development of county estates. On the same line, the private sector are key project strategic partners with 536,674 affordable housing units in the pipeline for development.

The programme also faced legal challenges when several cases were lodged to stop the mandatory contributions to the Housing Fund. Further, tenants who did not want to vacate land earmarked for affordable housing went to court, which took some time to resolve. The affordable housing framework was predicated on having off-take for investors from the Housing Fund. However, voluntary contributions have yielded Ksh 597 million cumulatively against an expected Ksh 9 billion per month as the mandatory fund was not implemented. Without mandatory contributions to Housing

Fund, alternative financing frameworks were proposed, including funding from the National Treasury. However, the programme has received Ksh 1.7 billion against an estimated cost of Ksh 1.7 trillion. This has slowed the projects' progress due to the prolonged arrangements with local banks and bulk purchasers. The project has faced delays in providing an enabling ancillary infrastructure due to lack of adequate budgeting as prospected, and therefore private developers have not invested in the affordable housing project to the extent prospected.

The presenter indicated that the Government has been at the forefront to address the challenges mentioned above and the emerging issues. Firstly, the financing framework has refocused on end-user financing mechanisms. Tax incentives and other benefits for private sector developers were imposed to encourage investment in AHP. The Housing Fund is now geared to operate on voluntary contributions and not mandatory.

The Affordable Housing Approach by the Government aims at ensuring continuous implementation by aligning to priority housing programmes (enablers). The Mega-City approach will open areas for housing development, thus planning for human settlement. Mobility linkage will be ensured through transport infrastructure by providing roads/SGR/BRT/railway and university cities approach. Similarly, the provision of technology and innovations, including expanded polystyrene (EPS), affordable building technology, green building concept, e-procuring system, and project/mortgage financing system.

8.10.2 Panel discussion

The panel session on housing was moderated by Dr Humphrey Njogu from KIPPRA, and focused on challenges in adopting technology in supporting affordable housing and possible solutions; the role of mortgage in providing affordable housing; and use of technology to promote environmentally friendly housing. The first question was on the challenges and possible solutions in adopting technology for supporting affordable housing. Prof. Romanus Odhiambo from Meru University noted that affordable housing is accommodation that is appropriate in the context of the standards and locality for lower and middle level households. The presenter noted that the key policy issues in implementation of affordable housing scheme include the building procedures and challenges confronted by developers. He noted that the industry is dynamic and emerging issues lead to the immediate changes to the entire housing and construction value chain.

The presenter also highlighted that financing is also a key constraint to implementation of affordable housing. With limited financing, affordable housing does not stand to be competitive with other modalities of provision of housing that mainly target the middle and high-end demand side. Similarly, lack of services infrastructure including access to electricity, safe drinking water, adequate sanitation and efficient transport system negatively affect the implementation of affordable housing. For instance, land and infrastructure account for 30 per cent of the construction costs, which are passed on to the end buyer, hence making the housing units unaffordable. In addition, lack of clear urbanization polices at the county level have resulted to delay in project development and ineffective land strategies, with multiple contradicting land tenures and policies and lack of digitized land system to curb the flaws. Concerning the building technologies, majority of the workers in the construction industry lack appropriate equipment and creative procedures to develop alternative building materials. The presenter recommended that a legislation and policies targeting low cost building strategies be enacted; consider provision of grants by the government for low- and middle-income earners; and ensure public private partnership policy is actualized.

Mr Colm Halley, General Manger from 14 trees limited, addressed the question on the role of mortgage in providing affordable housing. The company is a joint venture between lafargeHolcim- witzerland, Bamburi Kenya and CDC, a United Kingdom Government investment institution. The company was set up to look at innovative solutions to accelerate development of affordable housing in Africa. The company is focusing on innovation as key in delivering affordable construction technology to make development of affordable housing effective and efficient. A key innovation by the company was building 3D construction in 2020 first in Africa, and have launched the world first 3D construction printed school. The 3D construction printing is the latest technology in innovation in construction space designed to make construction faster, cheaper and crucially lower in carbon emission. The size of housing demand in Kenya and Africa is huge. Notably, 3D technology provides solutions to this problem. The technology will be brought to Kenya late in 2021 and the company is planning for the world largest 3D construction printed for the affordable housing project in Kenya. The presenter indicated that some of the key challenges to affordable housing is lack of affordable mortgage financing. He noted that science, technology, and innovation could lower the cost of construction and make housing units affordable.

Mr Bucha emphasized on the use of technology to promote environmentally friendly housing and key in providing affordable housing. The Government has come up with National Housing Corporation EPS factory that produces expanded panels, which are environmentally friendly, easier to build and faster in provision of housing. In addition, there is a technology that produces brick with numerical machine that uses hydraulic technology to produce the stabilized swell bricks. These technologies aim at making construction faster, easier and cheaper.

Mr Bucha also alluded that most Kenyans cannot afford the high cost of a mortgage, whereby cost of financing mortgage in banks ranges from 13 per cent to 30 per cent. However, the Government has introduced the Kenya Mortgage Refinancing Committee (KMRC) under the National Treasury to provide funding to primary lenders, who are the banks and SACCOs. The primary lenders extend affordable mortgage to individuals. The Government has also offered a Tenant Purchase scheme (TPS) whereby individuals pay for houses as they pay rent and own the house for 20-25 years.

8.11 Presentations from the Break Away Groups - Housing

The break-away group on the theme "Building Resilience with ST&I" was moderated by Mrs Nancy Laibuni and had two presentations: Delivering adequate and affordable housing using novel sanitation technologies by Mr Charles Macharia; and legal framework on mitigating building failures: A critical ingredient for safe and secure affordable housing in Kenya by Mr Bucha Patrick Mwenda.

The paper by Mr Charles Macharia provided an overview of the fundamental importance of sanitation in housing and made the case for novel sanitation technologies needed to deliver adequate and accessible housing in Kenya. Affordable housing programme under the "Big Four" agenda is aimed at addressing the citizen's rights guaranteed under Articles 43 (1) (b) and 42 of the Constitution of Kenya, and SDG targets 6.2 and 11.1. Article 21 (2) provides that the State shall take legislative, policy and other measures, including the setting of standards, to achieve the progressive realization of the right. However, the link between sanitation and housing remains weak, with majority of households, predominantly in low income and informal settlements, living in extremely hazardous housing conditions. These challenges include: acute water shortage, low sewerage coverage, inadequate fecal sludge and wastewater management services coupled with insecure tenure and inadequate spaces and privacy. This has perpetuated poor sanitation practices and limited use of alternative novel onsite (non-sewer) sanitation technologies, which exist in various degrees of sophistication, in affordable housing development schemes. Overall, he noted that ST&I can be harnessed to assist in designing

affordable housing projects that offer high quality of life. Several options exist in the sanitation sector that can be pursued by decision makers. For instance, the simplified/ condominial sewer system, which is constructed using smaller diameter pipes laid at a shallower depth and at a flatter gradient than conventional sewer.

The second presentation on *Legal framework on mitigating building failures: A critical ingredient for safe and secure affordable housing in Kenya* was delivered by Mr Bucha Patrick Mwenda. The presentation highlighted how a robust legal framework was essential in addressing the challenges of building failures to ensure safe and secure affordable housing in Kenya. The "Big Four" agenda as prioritized by MTP III intends to construct 500,000 affordable houses by 2022. The aim is to address acute shortages of housing. So far, the demand for housing stands at 250,000 units every year against provision of 50,000 units. Attempts to address this shortage has necessitated construction of high-rise buildings due to scarcity and high cost of land, and especially in urban areas. As a result, the presenter noted that developers took advantage of the situation to construct sub-standard buildings using sub-standard materials, including engaging unqualified contractors and professionals.

The presentation identified the challenge of governance institutions that are mandated to manage the building sector as lack of capacity to monitor construction works, resulting to non-compliance with regulations, specifications and standards.

To accomplish the study, Mr Bucha noted that his population of study was drawn from the National and County Governments, and regulatory professional bodies in the building sector. Further, the primary data was collected by use of structured questionnaires.

Overall, the study found that the legal framework was statistically significant on mitigating building failure and that building by-laws, building regulations, building contracts and building code are mostly used to regulate the sector. Other findings were that the legal framework had inadequate sanctions and penalties for non-compliance, and also lacked enforcement mechanisms.

The study recommends a review of the building code and other pieces of legislation and establishment of legal entity to harmonize the administration and implementation of building laws.

8.12 Emerging Issues and Recommendations

Emerging Issues

The following were the key emerging issues identified:

1. Emergence of pandemics such as COVID-19 present a threat to the sustainability of health systems.
2. There has been increased competition for global aid among different nations due to the vulnerability caused by COVID-19, thus limited access to funds.
3. The application of technology to realize maximum productivity and efficiency is becoming a reality in all areas of production.
4. Despite the promulgation of the Constitution of Kenya (2010), which allocates the functions and power of National and County Governments and the establishment of the National Construction

Authority in 2011 and the National Building Inspectorate in 2025 to manage the building sectors, the situation on construction of substandard buildings is still rampant.

5. Inadequate information on the state of infrastructure, coverage of sanitation services, the types of technologies in use, including their functionality is one of the biggest barriers to development of the sector. This hampers the ability of the market to respond to supply-side needs.

6. Inadequate policy guidance on onsite sanitation and disposal of sanitary products such as diapers has led to worsening of sanitary facilities by blocking sewer lines and drainage systems, causing sewage backflow in human settlement.

Recommendations

The following recommendations were proposed:

1. Adopt ST&I into disaster risk management and harmonize DRM policies, legislative and institutional frameworks to make Kenya's disaster risk management more effective and improve preparedness.

2. Enhance disaster risked preparedness at the local/community level.

3. Formulate policies to promote investment in Blue economy through foreign direct investment, development partners and public-private partnerships.

4. Mainstream digitalization into the Industrial Policy. As such, prepare a National Digital Industrial Policy.

5. Harness Kenya's digital capabilities characterized by advanced telecommunication and mobile money sectors by the manufacturing sector.

6. Consider allotting funds directly to the other sub-sectors prioritized by the "Big Four" agenda within the manufacturing sector, such as steel and iron, lime, cement, fish-processing, oil, mining and gas and Information Technology (IT) related parts assembly.

7. Consider investing more in development of infrastructure and human capital capacity to help in local vaccine development and self -reliance.

8. Invest in capacity building and implement supporting policies and legal frameworks to help improve food security in Kenya.

9. Commercialize new technologies such as the chicken banda logic technique to ensure increased uptake and utilization to increase chicken production and subsequently enhance food security.

10. Review the building code law on standards as the country depends on the Uniform Building Code of 1967, which does not consider the dynamics in the industry, including the emerging building technologies such as 3D printed houses, green and smart building and construction materials. Therefore, the building and housing sector needs to harmonize laws that guide the sector and coordinate the County and the National Government for resilient structures.

11. Ensure sanitation is integrated in housing as a basic service in its entire scope from capture and containment to conveyance, treatment, disposal and end-use. This is in keeping with the African Sanitation Policy Guidelines (2021).

Chapter 9: Industrialization and ST&I

9.1 Overview

This session chaired by Mr Saresh Patel from Kenya Association of Manufacturers (KAM) dealt with Industrialization and ST&I with a focus on the 4th Industrial Revolution. The presentations dwelt on understanding the steps taken by Kenya to harness the powers of ST&I in driving the industrial growth and the achievement of the Kenya Vision 2030. The 4th Industrial Revolution that focuses on Artificial Intelligence (AI), blockchain, big data and the use of Internet of Things (IoT) presents a novel opportunity for Kenya to transform its industrial output. The sessions on whether Kenya is ready for the 4th Industrial Revolution by Mr Philip Thigo set the stage for a discourse on opportunities that Kenya can utilize to achieve its goals. Other presentations: SMES and ST&I, Launch of Kibo satellite and panel discussion highlighted the milestones that Kenya has achieved in implementing ST&I in its quest to reinvigorate various sectors of the economy. The panelists for this session were: Dr Christian Tiambo (ILRI), Prof. Hamadi Iddi Boga (PS, State Department for Crops Development and Agricultural Research), Dr Jonathan Munguti (Kenya Marine and Fisheries Research Institute, Mombasa) and Mr. Edgar Onyango (Scaling Up Nutrition Civil Society Alliance).

9.2 Are we Ready for 4th Industrial Revolution?

The session was presented by Mr Philip Thigo, *Senior Director for Africa, working for Thunderbird School of Global Management.* The presenter acknowledged that we are in the Fourth Industrial Revolution. The first Industrial Revolution involved steam, the second involved electricity and the third involved automation. Therefore, the fourth revolution is a fusion between the physical, digital and biological spheres, referred to collectively as Cyber-Physical Systems.

It was noted that the current rapid course of change of these technologies are disruptive, affecting how people live, learn and work. These technologies are characterized by the presence of robotics, smart phones, supercomputing, virtual reality (VR), Artificial Intelligence (AI) and the Internet of Things (IoT), which shape human interactions.

In addition, the technologies that drive the Fourth Industrial Revolution comprise of Artificial Intelligence (AI), blockchain, big data and the Internet of Things (IoT). He pointed out that the trends driving this revolution are globalization, mobility, new behaviours, technology which includes big data, collaboration platforms, internet of things, robots and automation, wearables, and demography.

Although the nation is ready in terms of infrastructure, the disruptions that come with the change need to be addressed for Kenya to realize its full potential. Also, it was stated that 52 per cent of work activities in Kenya are subject to automation, hence the need for the country to strive being ready for the 4th Industrial Revolution. Some of the top ten emerging jobs because of using technology are data analysts and scientists, AI and machine learning specialists, general and operations managers, software application developers and analysts, sales and marketing professionals, big data specialists, digital transformation specialists, new technology specialists, organizational development specialists, and information technology service. Despite these opportunities, institutions of higher learning are lacking behind in embracing this opportunity.

The nation can be future ready by ensuring that data and data systems, including privacy and security must be up to speed since citizens cannot do anything without data and AI. To achieve this, the energy sector must be resilient, ensure affordability and availability of internet capability and affordable access is for people. The capacity should involve rapid skilling, re-skilling, and upskilling to match the change in technology. Also, agile governance involves not only how technology is governed but also how the technology governs itself so that the technologies even in their disruptions are inclusive.

The presentation brought to attention the fact that these technologies should be able to help the planning and delivery of public goods and enabling individuals to build new business models such as in housing, blockchain and 3D printing. In addition, they ought to enable new financial instruments such as smart mortgages and new engagement models with citizens in terms of governance. Therefore, the conclusion of this matter is that a future-ready type of leader who not only understands new technologies and innovation but is ready for the fourth industrial revolution is needed. For this, some of the needed skills mentioned are adaptability, problem-solving, a global mindset and ability to interpret data.

9.3 Artificial Intelligence

Artificial Intelligence (AI) amplifies human ingenuity to help employees do more, achieve more and learn more. There remains a wide gap between organizations that have embraced AI since they have a powerful lever to advance their business than those that have not. Organizations that have embraced AI are putting into action and connecting their strategic priorities in meaningful ways that can last. The real value of AI is when you put it in the hands of every employee, which requires organizations to skill, reskill and upskill their employees.

AI needs to be designed and used responsibly. Organizations that are finding the most value from AI have taken time to develop responsible approach by creating guiding principles that include fairness and transparency in implementing governance. Following these practices, AI can responsibly maximize the risk, especially in these times when everybody is virtual. Making AI meaningful is different for every organization because it is inherently connected to unique business goals; for some, it will be about finding efficiencies and automating workflows to focus on employees for a higher work level and for others, it will be about finding smarter ways to delight service for customers. For entrepreneurs that focus on what is absolutely business critical and looking to capture those opportunities that truly make

a difference, AI will be key in the achievement of their goals. To put meaningful AI into action, there is need to plan with purpose to drive impact by using data to design business development goals that are agile and build an AI readiness culture by upskilling employees and making AI accessible.

AI powered organizations put customer in focus, empowers employees with AI and connects data across the organization. AI ready culture puts data at the center of its operation, empowers employees at every step and innovates responsibly.

AI organization models are three, namely: centralized AI- small groups in full control of AI, decentralized AI-no central group in control of AI and AI powered organization, which have centralized principles for AI with scale innovations connected to the business.

9.4 MSEs and ST&I

The Micro and Small Enterprise Authority (MSEA) was established to promote, develop, and regulate micro and small enterprises in Kenya. MSEA offers infrastructure development for MSEs, job creation and capacity building. The Authority envisions to support Kenyan MSEs to become globally competitive, and selling products across Africa and the World.

MSEs face various challenges such as access to affordable finance/credit, knowledge and skills gap, corruption, regulatory bottlenecks, lack of appropriate technology and operation as informal entities. Some of these challenges can be addressed through Science, Technology, and Innovation (ST&I) that enhances transfer of skills and knowledge. In the country, MSEs are working together with other stakeholders such as Microsoft, Stanbic and Equity Bank to enhance digital literacy across the country. The other challenge is resource constraints where micro entrepreneurs face the inability to access credit from traditional financing models and other government initiatives such as guarantee schemes and start-up grants. Technological constraints such as standardizing and certification of products by MSEs for safety and quality assurance further limit harnessing full potential of the MSEs sector.

MSEA has plans to establish ST&I initiatives to support MSEs. The first initiative is to establish Industrial Development Centre (IDC) in every constituency for value addition or local economic activities and capacity-build MSEs to engage economically. The second initiative is digital literacy training to enhance the awareness of MSEs across the Country. The third initiative is the Kenyan Youth Employment and Opportunities Programme (KYEOP) and Mbele na Biz (BPC), which is expected to trigger entrepreneurship culture and native innovations. Mbele na Biz is a business competition plan where the target beneficiaries are 700 startup entrepreneurs who come up with a business plan and, if bankable, it is financed through a grant of between Ksh 900,000 and Ksh 3.5 million. Lastly is the market linkages and technology transfer where Kenya is moving to fourth industrial revolution. In Kenya, the informal sector is large, but it has not reached a level of global competitiveness. MSEs need to be organized in different clusters to support collaborations that enhance competing at the global level.

Further, the MSEs policy focuses on science, technology and innovation and recognizes the significance of skills and capacity of MSEs in productivity growth, policy interventions that will seek to provide holistic demand-driven and well-structured capacity building programmes, promotion of skills and technology transfer promotion, promotion of linkages and research institutions for technology development and transfer to MSEs, and creation of awareness on initiatives on skills certification and mainstreaming needs of Persons With Disabilities (PWDs) in skills development.

There are various opportunities to support MSEs, such as investing in digital literacy, upskilling of MSEs, providing incentives for digitization of MSEs, fostering intellectual property right use, exploring partnerships for technology transfer, and developing an effective and inclusive national innovation system.

9.5 The Launch of KIBO Satellite

The Nano satellite building programme was established in September 2015 in partnership between the University of Nairobi (UON and University of Rome with the main goal of designing, building, and launching a student-built 6U (20cm x30cm) Cubesat in three years. The 1KUNS-PF team responded to the announcement of a 1U Cubesat from the JEM KIBO deployed on ISS by Japan Aerospace Exploration Agency (JAXA). It was a global competition in which UON won the first opportunity to deploy a 1U Cubesat.

UON engaged in building the Cubesat where the payload consisted of 2 commercial cameras and uploading broadcast receiver based on a mobile phone application. On 16 January 2018 at JAXA Headquarters, Tsukuba Space Centre in Tokyo, Japan the UON team handed over the first nano satellite as 1U Cubesat (1KUNS-PF). This is the first satellite operated by a Kenyan University. 1 KUNS- PF is also the first outer space object registered by Kenya and the first Kenyan satellite to go into orbit.

On 2 April 2018, 1KUNS-PF was successfully delivered to ISS by falcon 9 Space X Rocket launched from Kennedy Space Centre in Florida, USA as the CRS14 Space X and on 11 May 2018, 1KUNS-PF was successfully deployed from ISS. By using KIBO, 1KUNS-PF mission goal has been achieved. After successful development of IKUNS-PF and achievement of the stringent standards required by JAXA for a satellite launch from ISS has given UON an opportunity to lead in the development of an outer space programme for Kenya to harness science and explore the peaceful utilization of space resources for the benefit of Kenyans and for those beyond the borders.

The satellite has operated in space for two years and it has proved that given the right backing and resources, Kenyan scientists can build and deploy a satellite since its endowed with a long coastline and the airstrip, since such resources have not been utilized. Kenya has an opportunity to inspire the next generation of scientists and engineers through space science by building on the success of 1KUNS-PF.

The University of Nairobi wishes to build on the success of 1IKUNS-PF by leading a 5-year programme of advancing outer space science and Kenya and developing satellite services by building and launching the following satellites

1. 2017/2018 1KUNS-PF 1XIU Nanosat in low earth orbit launched in May 2018
2. 2018/2020 NaSPUoN 1X3U Nanosat for providing designated services
3. 2020/2023 NaSPUoN 4X3U Nanosats for providing designated services

Depending on the mission goals for each year of the space programme, the cost of design, manufacture, launch per nanosat and gradual setting up of the requisite laboratories will require substantial financial commitments. The satellite development activities in each year will incorporate new mission goals. It is proposed that every year, MSc and PhD students who show a great passion for space science will be recruited to join the satellite design, manufacturing, launch and mission operations teams.

Some of the areas where satellite technology can be applied through nanosats constellation may include earth mapping and earth observations, weather forecasting, applications in agriculture, transport and food security, multimedia communication, disaster management, coastline monitoring, field communication, education, other space observations, land use monitoring, environmental, livestock and wildlife management. The University of Nairobi has also identified partners/sponsors to work with them to execute the program that will yield enormous benefits for Kenya.

9.6 Panel Discussion

The panel session on industrialization and ST&I was moderated by Mr Saresh Patel and focused on two key areas, namely: the challenges Kenyan innovators are facing and how that can be remedied, and Intellectual Property Management and its role in spurring innovation. The panelists noted that Kenyan innovators are facing a lot of challenges in putting their ideas into use. A case was given of Auto Truck Limited, the innovators of electric tuk tuk and carts, who faced a lot of hurdles before their idea was accepted by financiers and industry regulators. The challenges are lack of seed capital to take off the innovations, delayed approvals for the products to be released into the market and lack of infrastructural support from the industry.

The panel discussed the role intellectual property played in the industrialization of countries such as South Korea, Japan, and Singapore. Those countries have mastered the art of generating the knowledge, distributing it and utilizing it for the benefit of their citizens. Intellectual property entails organizing knowledge that comes from research and packaging it for use by entrepreneurs. There are gaps in our policies that are preventing us from packaging our knowledge in a way that it will benefit the country. There is need for infrastructural support from the industry, private sector, and the Government so that innovators can put their ideas into action. For instance, the case of Jomo Kenyatta University of Agriculture and Technology (JKUAT) has ten patents and 21 utility models but has not been able to role them out due to lack of infrastructural support.

9.7 Emerging Issues and Recommendations

Emerging Issues

1. Poor intellectual property management has impeded Kenya innovations from benefitting the country as ideas are not put to action
2. Policy deficiencies on ST&I and innovation have made it difficult for innovations to get approvals from relevant regulatory bodies
3. Lack of seed capital has hindered innovators from bringing their ideas to fruition, and absence of infrastructural support has hampered the role out of innovations

Policy Recommendations

1. More emphasis to be put on intellectual property management to spur innovations and make them beneficial to the citizenry.
2. Provision of infrastructural support to innovators by the Government, private sector and the industry.
3. There is need to relook into the policies on ST&I and remedy their deficiencies.
4. Provision of financial support to innovators right from the development of prototype to role out into the market.

Chapter 10: Youth Side Event

10.1 Overview

The youth are an essential components of a nation's development, owing to their large numbers, their energy, vibrancy, creativity and innovativeness, and other productive potential. Therefore, this theme event investigated ways of engaging the youth through 3 sub-themes: opportunities for youth within ST&I, commercializing innovations, and youth activities.

10.2 Opportunities for Youth with ST&I

In Kenya and globally, the youth have a valuable role to play in helping to achieve the country's development agenda as outlined in the "Big Four" and the Kenya Vision 2030. If well tapped, trained, and mentored, the youth can benefit themselves and the other segment of the population through ST&I. For example, the youth constitute about 32 per cent of Kenya's population, which translates to a large workforce. A discussion with a cross-section of university students and other youth I dwelt on their sentiments about their potential, the investment opportunities they need to succeed in the ST&I field, the training and mentorship opportunities available for them to explore ST&I, their participation in the agenda-setting for ST&I, and how to address the constraints that they face in wanting to innovate, and how youth can harness ST&I for job creation, entrepreneurship and empowerment.

10.3 Commercializing Innovations

Inventions, innovations, and new technologies should translate to economic or social benefits or returns to the producers. Finished products and services should access the market where exchanges or transactions can take place. An understanding of the markets for inventions and innovations was therefore key. In addition, an understanding of the commercialization process and pathways towards commercialization would aid in addressing any existing gaps. The sub-theme also highlighted

the roles played by innovation hubs, incubation centres and technology transfer centres in helping commercialize innovations, financing and other support for commercialization, and adaptation and uptake of innovations. An assessment of lessons or best practices for commercializing innovations was also discussed.

10.4 Youth Activities

The youth benefited from a mentorship session with professionals in the ST&I field on their role in promoting and using ST&I for development and empowerment. A talk on promotion of youth agency in ST&I, and a youth session on how other youth are making progress in ST&I. Songs and spoken words or entertainment was delivered based on the subject, and a display of exhibitions of some of the innovations developed.

10.5 Plenary Session on Science, Technology, and Innovation in Academia

10.5.1 Youth Empowerment through ICT

The presentation on "Youth empowerment through ICT" was made by Dr Matthew Egesa, a social innovator, researcher, and a full-time faculty member at Technical University of Mombasa. He is currently setting up the Blue Economy Innovation Hub that seeks to support social innovation in the Blue Economy within the Coast of Kenya. He has a background in Computer Science. The presenter sought to inform the youths on how they can empower themselves in the ICT space.

Youth empowerment is a process where young people are encouraged to take charge of their lives. It aims at improving the quality of life of the youth by addressing their situations and taking action to improve access to resources and transform their consciousness. The presentation highlighted various empowerment types, namely: psychological, community, organizational, economic, social, and cultural just to mention a few. The youth ought to use ICT to realize their potential.

Youth empowerment through ICT can be achieved through economic empowerment where technology skills can be harnessed to create employment. Youths can take advantage of engaging in start-up innovations such as mobile applications, technology products, software, web and graphic designs and data science and analytics to grow their skills and talents and earn a living. The youths in Kenya can take advantage of various platforms such as Innovation/Incubation/Acceleration Hubs to improve their ICT skills. As part of the Government's effort to prepare the youths for ICT-based jobs, the Government has rolled out the Ajira Training programme. The Ajira programme trains the youth in data entry/management (that include analysis, processing, mining, encoding and conversion), virtual assistance, digital marketing, and e-commerce, writing, translation, and transcription.

Emerging Issues and Recommendations

1. Even though the Government has earmarked ICT to be a driver for economic empowerment for the youths, there is a disconnect in funding of empowerment programmes. The curriculum in Kenya is also limited in ICT practical skills and mostly focuses on passing exams.
2. The Government needs to operationalize policies and strategies to ensure that ICT-related programmes are well funded. The Ministry of Education needs to restructure the curriculum

to support ICT skills identification, nurturing and development to enable the youths to create employment, earn a living and grow the economy.

10.5.2 Commercializing innovations to enhance opportunities for youth in ST&I (entrepreneurships, patenting, job creation)

A presentation on commercializing innovations to enhance opportunities for the youth in ST&I was made by Ms Lizzy Mwamburi, an Associate Professor of Plant Sciences at the University of Eldoret. She holds a BSc degree from Moi University and a Masters degree from the University of Melbourne, PhD from the University of KwaZulu-Natal and post graduate studies from Gottingen University, Germany. She is a recipient of several scholarships and grants including Equity and Merit Australian Government Scholarship, Commonwealth Scholarship, British Council Fellowship, Organization for Women in Science in the Developing World Fellowship, The World Academy of Sciences (TWAS) – DFG fellowship, National Research grant, American Society for Microbiology Course for Undergraduate Educators (ASMCUE) Leadership Grant for International Educators, Australia Awards Africa and The World Academy of Sciences (TWAS) Research Grant. She has mentored 30 postgraduate students (both MSc and PhD) and has participated in several mentorship programmes including the New York Academy of Science, 1000 girls 1000 futures, INASP Research writing and Akili Dada. Her current research activities involve biological control of insects using bacteria and fungi and wastewater reuse. She has over 50 publications.

Research is important because it can lead to introduction of new products. It also improves the quality of a particular subject matter and peoples' livelihoods. Commercializing research can be described as the process of carrying out research with the overall objective of selling the research output. Cultural acceptance is one of the key elements to consider while choosing the area of commercial research. Other factors to consider include: the use of proper methodologies, adherence to research ethics, utilization of good reliable data, the process of investigating and selling the outcome(research). When researching on a theme, it is vital to engage and collaborate with relevant professionals, universities, and research institutions to ensure your output is relevant and all-inclusive.

The process of commercialization starts at the research development. Campaign methods (advertising), communications (public relations), sales and pricing are other steps in commercialization. The researcher needs to select the right team and contact the right institutions such as NACOSTI, KIPPRA and KIPI to assist in effective commercializing of research and use the right channels to commercialize research to avoid intellectual theft. The advantages of commercialization of research are wide-ranging choices to customers/clients, revenue generation and promoting efficiencies. Universities and researchers also benefit from commercialized research as it expands their visibility. Wide visibility can, in turn, attract funds, sponsorship and collaborations. Lack of resources and funds, poor managerial skills, high competition, and high-risk factor are some of the challenges and disadvantages of commercialization of research.

In closing, commercialization of research has a huge potential when it comes to job creation and improvement of livelihoods. Collaborations between researchers and relevant organizations such as KIPPRA and KIPI can help improve the quality of research and prevent research theft. The youth can explore commercializing research in ST&I as an opportunity for entrepreneurship and job creation.

Emerging Issues and Recommendations

1. There should be more support and education to the youth on matters research and commercialization of research.
2. The Government could come up with more programmes that support and fund research carried out by the youth.

10.5.3 Promoting the Agency and Participation or Engagement of Youth in Matters of ST&I

The role of Kenya Youth Empowerment Opportunity Project (KYOEP) in addressing youth unemployment in Kenya was presented by Ms Zipporah Konga from the State Department for Youth Affairs. KYOEP is a Ksh 15 billion national project funded by the World Bank and the Kenyan Government, designed to equip young people between the age of 18 to 29 with life skills training, core business skills training, internship opportunities or work experience and support for businesses that would enhance their capacity to secure sustainable livelihoods. The project is coordinated by the Ministry of ICT, Innovation and Youth Affairs (MIIYA) and implemented by the National Industrial Training Authority (NITA), Micro and Small Enterprise Authority (MSEA) and Ministry of Labour and Social Protection.

KYOEP supports young people by addressing skills mismatch through realigning their skills to provide youth employability through trainings; providing them with entrepreneurship lessons and offering grants to start their own businesses; improving labour market accessibility; offering labour market information to prevent exploitation; and strengthening of youth policy, development and project management. The project also targets school dropouts to provide them with opportunities. Currently, KYOEP is rolling out the Kenya Youth Development Policy-2019. This policy has embraced the emerging issues in the ST&I by addressing issues such as cyber security, virtual work environment, and e-commerce.

Emerging Issues and Recommendations

1. KYOEP has launched strategies to reach out to the youth in rural areas through youth representatives at the respective sub-counties in the 47 devolved units. However, majority of the youths have limited knowledge of the purpose and engagement avenues with the project.
2. It is recommended that a robust awareness programme on multiple avenues such as social, print and digital media be carried out to reach out to more youths who stand to benefit from the project. Sub-county youth representatives could be identified to engage community leaders and popularize the project among the youth.

10.6 Plenary Sessions

This was a plenary session on Science, Technology, and Innovation (ST&I) in Academia. The discussion was moderated by Dr Michael Walekhwa, a lecturer of Immunology at Kabarak University. There were three panellists: Dr Liz Mwamburi, Ms Zipporah Konga and Dr Matthew Egesa. The panel discussion dwelt on: labour market information and job mismatch, how university students can engage with KYOEP, how do universities benefit from commercialization of innovative research, and how cultural innovations and ideas can be harnessed to benefit the youth and the society.

When seeking for jobs, the youth are turned away because they do not qualify for the advertised positions, although some of them have minimum qualifications. KYOEP, through its various partner implementors, have put in place frameworks to train the youth by bridging the gap for skills mismatch. This is done through offering short courses to help the youths to meet the job specifications. The National Industrial Training Authority (NITA) is instrumental in training the youth who had dropped out of the school to acquire skills to help them set-up jobs and even secure employment. To benefit, youths must be proactive and look out for these opportunities to enable meet job requirements.

On how university students can engage with KYOEP, many graduates feel that they are locked out since KYOEP targets the vulnerable youths. Therefore, some do not see the need to engage with KYOEP. It is important that university students engage with KYOEP as they are master craftsmen. They can train their fellow youth in specific skills and help in reaching other vulnerable youths in the communities. In addition, the youth can seek for further information from KYOEP social media and get to learn more on opportunities the youth stands to benefit from.

Another issue related to how universities can benefit from innovative research. Many research outputs are not commercialized and are only used in the academia. On the contrary, universities' innovative research creates visibility for universities, generates funding, and helps attract more students due to availability of funds. The universities also create a channel to equip the youth with ST&I skills through their innovation hubs and incubation centres. This goes a long way in creating job opportunities for the youths and for economic empowerment.

The final area of focus was on how cultural innovations and ideas can be streamlined and incorporated in the mainstream innovation system. The panelists observed that many innovative research outputs are collaborative and multidisciplinary in nature to harness the benefits from various stakeholders. The youth need to work together with diverse persons to benefit from cultural ideas.

Emerging Issues and Recommendations

1. Policies to govern youth empowerment in ST&I, awareness of labour market information and job mismatch is limited. There is need, therefore, for the Government to put in place sufficient strategies for awareness of Government programmes to empower the youths, trainings in labour market information and reskilling to meet job specifications.

10.7 Plenary Session (SE_1) – Science, Technology, and Innovation (ST&I) in Academia

Promoting innovation and entrepreneurship among the youth - Jean Paul Adam

Mr Jean Paul Adam made a presentation on promoting innovation and entrepreneurship among the youth. He is currently the Director for Technology, Climate Change and Natural Resources Management in the United Nations Economic Commission for Africa (UNECA). Prior to taking on this role, he served in the Government of the Republic of Seychelles in several Cabinet positions. He was Minister of Health from 2016 to 2019. He served as Minister of Finance, Trade and the Blue Economy from 2015 to 2016 where he negotiated a debt for climate change adaptation swap and launched the process for Seychelles to become the first issuer of a Blue Bond. Between 2010 and 2014, he was Seychelles' Minister of Foreign Affairs, where he advocated for countries to embrace the concept of the Blue

Economy to improve sustainability for island and coastal countries. He holds a Masters degree in International Political Economy from the University of Manchester (UK) and a BA in English Literature and French from the University of Sheffield (UK).

A recent study done by UNECA shows that the general innovation policies in Kenya are inadequate. Other African countries have similar innovation policy environments. The findings of the study showed that there is still a lot to be done in terms of innovation policies and addressing barriers of innovations among the youth, like innovation financing and digital access. Innovation financing could be improved through financing of early-stage start-ups, micro-financing and micro-loan programmes, upscaling of guaranteed schemes from the government, loans and equity provided by the government, development of networks, relaxed regulation for second tier stock markets and stimulation of venture capital availability. The digital access barrier hampering innovation progress is mainly due to high cost of data. Despite the digital access in Africa rapidly improving, Africa's digital access is still low with a significant higher data cost compared to the regions of the world.

UNECA and its partners are working to address issues dealing with ICT infrastructure and innovation investments. There has been an increase in the number of innovation hubs across Africa in the recent years. Kenya has the 4th highest number of active innovation hubs among African countries. The types of hubs in Africa include incubators, co-working, accelerators, and innovation. There are also hubs that have been set up to address emerging issues such as the COVID-19 pandemic and climate change, that are costing African economies 5 per cent of their GDPs. UNECA is also supporting universities and is promoting the concept of innovator schools. The universities participating in the innovators schools have increased from 6 in the year 2012 to 17 in the year 2019. The bio-medical engineering schools and the African digital transformation strategy are examples of UNECA's innovation initiatives. The innovation eco-system for bio-engineering schools link universities with NGOs, hospitals, research and development centres, other African and foreign universities, and industries. Investments in the ICT space within the African continent act as an accelerator for digital access, economic growth, and job creation.

In the era of the Fourth Industrial Revolution, UNECA is involved in making the revolution work for Africa. They are focusing on emerging technologies such as artificial intelligence (AI), 5G technology and nanotech. There is a pilot project at the Congo to investigate the potential benefits of 5G. Other African countries are rolling out 5G technologies through the support of mobile service providers. The African Research Centre on AI is also to be set up in the Congo. The vision of the centre will be to orient the use of AI to foster economic and social development in the region. Nanotech use is growing in the continent, based on the increasing research on nanotech in Africa. The African Medical Supply Platform (ASMP) has been developed to support response to the COVID-19. The ASMP facilitates the provision of COVID-19-related medical products and vaccine procurement. UNESA has also been promoting access to coding. The Girls Coding Camp launched in December 2020 offers coding skills targeting young women and girls. The UNECA also promotes digital innovations through the ECA-AUC Digital Transformation and ID Programme. The programme aims at making service provision better across the continent by addressing the informality of African economies.

Emerging Issues and Recommendations

1. The lack of finances, supporting polices and high cost of data in Africa is a barrier to digital access, innovations, and entrepreneurship.
2. The Government could come with more polices and incentives that spur innovations and spread digital access at a low cost.

3. More research and collaborations between Government and relevant institutions on emerging technologies such as AI and 5G should be encouraged to help Africa embrace the fourth industrial revolution.

Investing in the youth through ST&I initiative

A presentation on investing in the youth through ST&I initiative was made by Mr Morris Ondiek. Mr Ondiek has over 10 years' experience working with young people in the areas of business. He has worked at COMESA as a coordinator for cross border trade, particularly in the capacity building programme. He currently teaches at the Kenya Institute of Business Training (KIBT) and works at the Youth Enterprise Development Fund. He is passionate about business and is a part time chef.

The Youth Fund is a Government parastatal whose main agenda is to support the Kenyan youth. The state corporation provides financial and business development support services to youth-owned enterprises. The Fund offers various loans with minimal application processes and requirements. Examples of Government support being offered are the procurement opportunities under the Access to Government Procurement Opportunities (AGPO) reserved for the youth, women and the PWDs. The youth need to identify market niches in everyday life and exploit them as business opportunities. The exploitation of ST&I has the potential to create business and jobs for plenty of young people. Use of ST&I can lead to improvements of the current goods and services being offered, thus presenting business opportunities to the youth. These opportunities exist in the input, process, and output (product) stages of business. ST&I has also been used to spur business growth. The growth maybe in form of productivity increase, client-base expansion, improvement in market/business efficiency, reduction in production cost and time or improvement of the quality of their products. The youth can use ST&I to focus in addressing the needs of the consumer and exploring entrepreneurship.

Emerging Issues and Recommendations

1. The youth need to stay informed on Government opportunities such as the various Procurement Opportunities under Access to Government Procurement Opportunities (AGPO) programme, loan offers and even the business/company establishment procedures.
2. The youth need to identify market gaps and think of innovative ways of improving or filling the current market gap.

Personal branding and emotional intelligence

A presentation on personal branding and emotional intelligence was made by Mr Domonic Mwangi, a lecturer in psychology at Tangaza University College. He is the founder and director of Planet Proxima Global Ltd, an education and entertainment company. He is a board member of Positive Psychology Association of Kenya, the second of its nature in Africa.

Personal branding refers to the intentionally developed competitive edge (competence and character) that makes one stand out from your competition and makes one more appealing to markets (customer and employers). Emotional intelligence is the ability to perceive, control and evaluate emotions. The ability to understand, interpret and respond to the emotions of other can also be defined as emotional intelligence. Emotional intelligence is important because it can lead to improved decision making, decrease occupational stress, increased leadership ability, increased team performance, reduced staff turnover and increased personal well-being. The building blocks of emotional intelligence are self-awareness, self-regulation, motivation, empathy and social skills.

Developing emotional intelligence can be done by learning to name ones emotions; paying attention to what makes one feel positive or negative; listening to understand and not to respond; practising gratitude; writing down one's goals; observing how and why you interpret tasks and considering other people's feelings. Personal branding and emotional intelligence help us become better versions of ourselves and at living with others.

Plenary Sessions

Some questions arose on the presentations on Science, Technology, and Innovation (ST&I), entrepreneurship and personal branding and emotional Intelligence.

1. Does the Youth Fund offer innovation trainings to university students?
2. How do we motivate the youth to continue coming up with innovative ideas despite the low uptake of youth innovative ideas at the hubs and by the Government?
3. What can people learn from online platforms such as twitter's amerix that promote male mental health?
4. Are human beings in a loophole between our emotions and cognitive processes such that our emotions will influence our cognitive processes and vice versa?

On responses given by the presenters, the Youth Fund offers trainings and supports commercialization of ideas. The young people should educate themselves more on the existing Government opportunities and utilize them. Further, the Government has various initiatives, trainings and programmes aimed at increasing innovations and entrepreneurship among the youth. The private sector has also invested in the areas of ST&I.

It was noted that human beings have both the cognitive processes and the emotions. They are not independent of each other, but rather influence each other and the overall action we take. However, the levels of each may vary from person to person. For example, someone can have a high emotional intelligence but may lack the cognitive abilities to handle certain situations. One with proper character should take into consideration both the emotional and their cognitive processes during decision making.

10.8 Plenary Session (SE_2) – Campus Lifestyle, Challenges and Coping Mechanisms

Students' mental health and technology

The presentation on "Student's mental health and Technology" was made by Mr Cleopah Kinywa Njiru. He is a marriage and family therapist and currently a senior hospital psychologist at Chiromo Hospital with 30 years of experience. Chiromo Hospital Group is a leading private psychiatric service provider in Sub-Saharan Africa. The institution has been in existence since 1997, providing quality in and out-patient services to persons from diverse backgrounds. The presenter highlighted the impact of technology use on mental health among the students.

The overuse of technology can have negative effects. Technology must be balanced with other aspects of life for an individual to remain healthy, mentally, and physically. The anxiety symptoms when one cannot access social media sites, or their phones creates a conflict in an individual's real life, thus lowering their quality of life. Additionally, cyber bullying that is orchestrated on social media negatively

affects the youth and drives them to depression, suicide and even Alcohol and Drug Abuse (ADA). The youth can harness the positive use of social media by setting a good example to others, encouraging others to talk about mental health and being supportive. Social media can also provide a platform where one can disseminate positive messages through posting their stories and even creating in-person meet ups geared towards positive mental health lifestyle. Also, students can disseminate information on mental health and well-being by starting their own mental health blog.

In conclusion, technology can be used by students to improve mental health by providing non-judgmental platforms where individuals can talk about their challenges, and give a voice to the silenced. These platforms should also provide opportunities for students to connect with others who have similar experiences. Further, role models can harness technology to encourage students on positive mental health lifestyle.

Emerging Issues and Recommendations

1. Majority of mental disorder patients find it hard to speak up about their experiences because of fear of being perceived negatively.

2. It is the responsibility of all stakeholders to ensure that students are guided, supported and informed on use of technology and mental health for them to take control of their mental health well-being.

Drug and substance abuse among students

A presentation on drug and substance abuse among students was made by Mr Adrian Kamau, a Senior Policy and Planning officer at the National Authority for the Campaign Against Alcohol and Drug Abuse (NACADA). His job entails supporting the development, implementation and monitoring of alcohol and drug control policy and programmes. NACADA is a semi-autonomous State corporation under the Ministry of Interior and Coordination of National Government as per the Executive Order No. 1 of June 2018 (Revised). It is established to undertake public education and awareness campaign against drug abuse among the youth in learning institutions and in the community.

According to the National Survey on ADA in schools, 2016 and 2018 report, the prevalence of lifetime uses of ADA among secondary school students revealed a worrying trend where 23.4 per cent of students have ever used ADA, with 3.8 per cent currently using ADA. Young persons who start to use alcohol before the age of 15 are 4 times more likely to use ADA later in life. It is important to, therefore, prevent early introduction of ADA because its effects interfere with social and economic well-being of a person through its negative impacts from addiction. The low productivity and the high cost of rehabilitation interferes with economic well-being of a person and further affects the achievement of national developmental goals through loss of labour. It takes between 3-10 years for one to transit to a full addict. The stages of addiction include experimentation, social use, use to manipulate one's emotions and behaviour and habitual use.

Despite the challenges of exposure that the youth go through in community and in learning institutions, they can find ways to cope especially when away from home. Possible ways to avoid ADA include engaging in activities such as co-curricular activities, which keeps them occupied, choosing their friends wisely and being accountable to their parents/guardians. They should also desist from peer influence to experiment with ADA. In conclusion, the presenter called upon the youth to choose their

friends wisely and reiterated that healing takes time and seeking/asking for help is a personal choice.

Emerging Issues and Recommendations.

1. ADA in learning institutions is becoming more prevalent. The use of alcohol and cannabis is on the rise among the youth in higher learning institutions and in the community.
2. Youths to take charge of their lives and desist from the urge to experiment with ADA because once the habit has been formed it is difficult to control. Additionally, the Government should establish stringent measures to control drug and alcohol peddlers around learning institutions and in communities to protect the youths against the scourge.

Gender-based violence in campus

A presentation on gender-based violence (GBV) in campus was made by Christine Okena, an Ending Violence and Against Women and Girls (EVAW) Consultant at UN Women. She is also an advocate of the High Court of Kenya, with experience in women's rights, access to justice, GBV prevention and response.

GBV refers to harmful acts directed at either an individual or group based on their gender or sex. It is deeply rooted in power inequalities, abuse of power and harmful norms. The various forms of GBV can either be physical, emotional, sexual assault, sexual harassment, or the soft-natured forms (like stalking and catcalling). Recent studies show that sexual harassment is the most common form of GBV in campuses. This encompasses various forms such as grabbing, pinching and slapping in a sexual manner and non-physical mannerisms such as catcalls, sexual comments, sexual demands, sexual suggestive staring and exhibitionism.

The impact of GBV, especially on the youth and learners, is long-term. This can affect either the physical or mental health or both. Research has shown that GBV survivors experience higher rates of stress disorder, depression, and substance abuse. UN Women and ActionAid have a joint programme that addresses sexual harassment in various Kenyan universities. From the interactions within the programme, the effects of GBV found are education disruptions, lower grades, changing courses and dropping out. An ActionAid study in 2019 showed that 49 per cent of women and 24 per cent of men of those interviewed have experienced sexual harassment from a university staff member. The staff members are either academic or support staff. 66 per cent of the victims were harassed by either a lecturer or a professor. The study also found that most victims do not report. Their main reasons were the negative social consequences, not knowing where or to whom to report to, lack of confidentiality and seriousness in handlining the cases. 38 per cent of female and 36 per cent of male students feel that the university would protect the perpetrators or not pursue the GBV case according to the study. The financially vulnerable and younger students were most affected.

In conclusion, universities bear the responsibility of care to the students and should have in place concrete procedures that address GBV. Effective prevention and response methods involve more than one-time programmes and awareness. There should be processes in place to allow confidential reporting and handling of any GBV incidences and support being offered to the victims. There ought to be fair and disciplinary processes that hold the offenders accountable. Universities need to develop more polices and codes on sexual harassment and have effective systems and structures to oversee the implementation of these policies. The social media influence and activities should also be monitored as it is also an avenue for GBV incidences and reporting.

Emerging Issues and Recommendations

1. There is lack of confidentiality and seriousness in handling GBV cases in campuses, with the university staff forming a majority of the GBV perpetrators.
2. Most students are not confident that GBV perpetrators will face any consequences as they feel they will be protected by the universities.
3. There is need to build safe spaces in our learning institutions and ensure confidentiality and seriousness when handling GBV student cases. These cases should also be taken with uttermost seriousness with both the victims and the accused getting fair justice carried out by independent bodies and Kenya's justice system.
4. There should be more continuous awareness programmes, trainings and survivor-centred approaches in addressing GBV in learning institutions among the student and staff, to help improve prevention and response.

10.9 Plenary Session (SE_3) – Youth Empowerment and Engagement

Career Networking and Challenges Faced in Transitioning into the Workplace

The session on "Career Networking and Challenges Faced in Transiting into the Workplace" was presented by Ms Dorcas Wainaina (OGW), the CEO, Institute of Human Resource Management and has a vast range of demonstrable skills and delivery spanning 21 years.

On being an upholding professional, the presenter reiterated that individuals are expected to display professionalism in their speech, wardrobe, and ethical mannerisms as one will be held accountable for any actions s/he participates in at work, or outside of work hours. The youth should always keep this in mind when posting or sharing content online.

Regarding new responsibilities, any career moves an individual makes after college comes with added responsibilities. Thus, an individual is held responsible for completing their work on time, getting along with fellow employees (being a team player) and reaching specific goals that are expected of him/her. The facilitator informed the youth that "years of experience" are often required of them by prospective employees, literally means the ability for one can do a certain job before getting that job and prove that s/he can bring value on the table. Possessing experience helps an individual to transition to top management with ease.

The youth were reminded on the need to equip themselves with skills even after college. It was noted that learning does not end once they leave school or get employed. They should keep on learning as starting a new job still requires a lot of learning on one's part. Ms Wainaina emphasized on the need for the youth to strive and acquire new skills and advancing knowledge, even through online platforms. Reaching out to co-workers for assistance and not fearing to ask questions is also important. Further, it was noted that potential employers value relationship building, teamwork, industriousness, flexibility, attentive listening, an ability to learn, and punctuality.

The presenter observed that while still in college or after college, the youth should seek for internship opportunities before employment or volunteer within the institution they know to improve on their skills. Additionally, the youths should utilize every chance and network with experienced professionals

to gain insight into organizational culture and job requirements. Technology platform can provide opportunity for online networking that removes the physical barriers.

In conclusion, when applying for a job or internship, one should ensure that skills are updated in the CV to keep them current regardless of the industry. This means staying up to date with various technology and industry trends to gain an advantage over other. The youths should also ensure they stay current by doing online research, and reading professional journals. It is important to stay focused on ones career goals and aspirations. An individual should let their experiences teach, guide and propel their future path.

Emerging Issues and Recommendations

1. The youth face challenges in transiting into the workplace. Despite their qualifications, they face rejection because of skills mismatch and lack of experience.
2. The Ministry of Labour and Social Protection needs to fast-track and expand the internship programme to help in instilling new skills to fresh graduates. More funds need to be allocated to training of youth in specific skills to prepare them for the job market.

Social media activation

A presentation on social media activation was done by Ms Samatha Luseno, an experienced data/policy analyst with a Master of Arts (MA) in Economics and a Bachelor of Science (BSc) in Actuarial Science and Mathematics from the University of Manchester, United Kingdom. She has over 4 years' experience in the review and articulation of policy issues across various social sectors including: education; health; social protection; water and sanitation; and special interest groups (women, children, youth, and persons with disabilities). She is currently working for a global data and analytics firm whose primary focus is decision focused social impact assessment in Africa and Asia. She is also the co-founder and Executive Director of 254 Youth Policy Cafe. Previously, she worked for the Government (National Hospital Insurance Fund-NHIF and the Kenya Institute for Public Policy Research and Analysis-KIPPRA), and Civil Society Organizations (Kenya Civil Society Platform on Oil and Gas - Publish What You Pay Kenya) in various capacities majorly revolving around resource mobilization, strategic planning, and research.

Social media activation is the transforming of one's social media followers from simply observers to participants. For the activation to take place, one needs to: attract (exposing your followers to meaningful experiences); engage (let your followers experience your brand) and bond (establishing an ongoing relationship). Personal branding is all about identity, value and promise. What makes you different form everybody else? Personal brand is who you are, what you offer, and to whom are you offering your skills to. One can learn on building their personal brand from other online posts, advertisements and platforms such as LinkedIn and YouTube. A profile is your representation on social media platforms. Having a professional picture on your profile is more appealing on professional online platforms. Your biography should be a description of who you are, your experiences, educational background and your interests.

Social media can also be used in the policy making process. The process has several stages which include problem identification; agenda setting; policy formulation; adoption (decision making); implementation; and monitoring and evaluation. Data collection, agenda setting, and public participation can be carried out online. Examples of such include social media campaigns, online verbal

or written expression on policy issues and virtual public participation. Social media can be used to provide critical insight on policy issues and measure the success of policy implementation.

Emerging Issues and Recommendations

1. The youth should use social media to build their personal brands. This can be done by constantly updating their professional status, sharing as much professional information as possible on their roles, achievements and responsibilities and learning from online platforms such as LinkedIn and YouTube.
2. Policy makers and stakeholders can make use of social media in the various stages of the policy making process.

Annexes

Annex 1: Main Conference final program

4th KIPPRA ANNUAL REGIONAL CONFERENCE

THEME: SCIENCE, TECHNOLOGY, AND INNOVATION IN ENHANCING DELIVERY OF THE BIG FOUR DEVELOPMENT AGENDA

23RD-25tH JUNE 2021 HYBRID

PROGRAMME

TIME	DAY 1: 23RD JUNE 2021
7.00- 8.00	KIPPRA DOCUMENTARY
8.00-8.15	ARRIVAL AND REGISTRATION
8.15-8.30	PRAYERS- CHRISTIAN & ISLAM JANET-Christian, MOHAMMED-Islam NATIONAL AND EAST AFRICAN COMMUNITY ANTHEMS (KIPPRA CHOIR) MC: Noah Kipkemboi
8.30-10.00	**Conference Overview:** Setting stage for Science, Technology, and Innovation in Enhancing Delivery of the Big Four Development Agenda (10 minutes) Dr Rose Ngugi Executive Director, KIPPRA **ST&I, Law, and the Constitution:** What We Need to Know (10 minutes) Dr Linda Musumba, Chairperson KIPPRA Board Interlude with Short Video Clip (2 Minutes) **ST&I Regulatory Framework & National Research Priorities** Presentation (10 minutes) Prof. Walter O. Oyawa, DG NACOSTI Interlude with Short Video Clip (3 Minutes) **Facilitating the Development of Information & Communication Sector, Regulations & Standards** Presentation (15 minutes) Mr Robison Busolo, Communication Authority **University Education & Research-Policy & Management** Presentation (15 minutes) Amb. Simon Nabukwesi, CBS PS, State Department for University Education and Research
10.00-10.30	INTERLUDE AND REFRESHMENT BREAK (KIPPRA CHOIR)
10:30 – 16:30	YOUTH'S SIDE EVENT (ANNEX 1: PROGRAMME) & EXHIBITIONS
THEME 1: STATUS OF ST&I IN KENYA	
PLENARY SESSION 1.1 – Status of ST&I in Kenya Chair: Dr. Katherine Gateo CEO, ICTA VIRTUAL	Rapporteurs: KIPPRA

10.30-11.50	**Trend in ST&I in East and Central Africa** Presentation (7 minutes) Dr Ann Kingiri, ACTS - Virtual **Access to ICT** Presentation (7 minutes) Dr Moses Thiga, Kabarak University **Role of FiN Tech in Deepening Financial Inclusion in Kenya** Presentation (7 minutes) Dr Samuel Tiriongo, Kenya Bankers Association Virtual Interlude with Short Video Clip (3 minutes) **Status of Industrial Technology (MoITED)** Presentation (7 minutes) Amb. Peter Kaberia, CBS PS State Department for Industrialization **PANELISTS - (30 Minutes)** (i-Lab Africa, Mr. Robert Mrima-Swahili PotHub- Virtual) Interlude with Short Video Clip (2 minutes) PLENARY SESSION - (10 minutes)
PLENARY SESSION 1.2 – Policy, Institutional and Legislative Framework Chair: Dr Linda Musumba, Board Chair KIPPRA Rapporteurs: KIPPRA	
11.50-13.00	**What makes a good ST&I Policy Objective?** Presentation (6 minutes) Prof. Sachin Chaturvedi RIS, India Virtual A short clip Relevant to the Subject (3) **Role of Ombudsman & Governance in the Promotion of ST&I Program, Policies & Practices** Presentation Washington Asati, Ombudsman Commissioner (PwD-Hearing) **Linking Jua Kali to Modern Technology and Innovation for Wealth Creation** Presentation (6 minutes) Mr Richard Muteti, KFJA

	PANELISTS – (30 minutes) (KIPPRA, Eng. Edward Karani Njeru-MSEA Virtual, Prof. Stephen Ogenga, Director General NITA, Regina Nkonge, iLab Africa) A Short Clip Relevant to the Subject (3) PLENARY SESSION – (10 minutes)
13:00	LUNCH BREAK Entertainment (Videos, Guess where?)
14.00-16.40	ANNEX 2: BREAK AWAY GROUP DISCUSSIONS PROGRAMME
THEME 2: DEVELOPMENT OF HUMAN CAPITAL	
PLENARY SESSION 2.1 Education Chair: Dr.Dinah Samikwo, Board Member KIPPRA	Rapporteurs: KIPPRA
14:00-15.30	**Educational System and ST&I** Presentation (7 minutes) Mr Stephen Ogenga , Director Genral NITA A Short Clip Relevant to the Subject (2) **Access to Education in 4th IR** Presentation (7 Minutes) Lake Hub **The Role STEM Education in Enhancing ST&I** Presentation (15 minutes) Mr Martin Mungai, Centre for Mathematics, Science, Technology Education (CEMASTEA) **STEM Education on sustainable socio-economic development** Presentation (7 Minutes) Dr David Njubi, NACOSTI A Short Clip on the Subject (2) **PANELISTS – (30)** (Dr Moses Thiga Kabarak University Ann Kingiri,ACTS VIRTUAL) PLENARY SESSION - (14 minutes)
15.30-16.40	Refreshment and Entertainment (Photo Gallery of Day's Photos, Screen shots of day's tweets)
16.40-17.30	PRESENTATION FROM THE BAGS AND STUDENT'S SIDE EVENT
TIME	DAY 2: 24TH JUNE 2021

THEME 3: BUILDING A STRONG INNOVATION SYSTEM	
7.00- 8.00	KIPPRA DOCUMENTARY
8.00-8.15	ARRIVAL & REGISTRATION
8.15-8.30	PRAYERS: CHRISTIAN & ISLAM NATIONAL ANTHEM- NATIONAL & EAST AFRICAN- KIPPRA CHOIR RECAP OF DAY ONE: Key highlights by Muleli Mutuku, KIPPRA MC: Noah Kipkemboi
Entertainment by; KIPPRA CHOIR	
PLENARY SESSION 3.1 – Innovation Systems Chair: Dr. Emmy Chirchir, Deputy Head of the East Africa Research and Innovation Hub Virtual Rapporteur: KIPPRA	
8.30-9.30	**P3.1 Media Coverage of ST&I for PWDs** Presentation (5) Luke Muleka, Signs TV **Innovation in Assistive Technology** Presentation (5) Eugene Muchai, Kilimanjaro Trust A Short Clip on the Subject (3) **Patenting and Intellectual Property Rights** Presentation (5 minutes) Sammy Ziro Lewa, Patent Examiner, Kenya Industrial Property Institute (KIPI) **PANELISTS -(20)** (Prof. Bitange Ndemo Virtual, Dr. Jaro Arero UNESCO Virtual, WEEE Centre Virtual,) Ms Monicah Mueni PWD, Wilson Macharia (PWD-sight Virtual) Linda Kwamboka iLabAfrica Virtual) A Short Clip on the Subject (3) PLENARY DISCUSSION - (10 minutes)
PLENARY SESSION 3.2 – Health Systems Chair: Dr. Humphrey Njogu Rapporteurs: KIPPRA	

9.30-10.30	**Role of ST&I on health care-Keynote** Presentation (15) Hon. Mutahi Kagwe, EGH CS, Ministry of Health **Impact of Technology on Health Care** Presentation (6 minutes) Dr Wanjala, KEMRI A Short Clip on the Subject (2) PANELISTS - (30) (Dr Gitahi Githinji Amref Kenya, Josia Rono e-Consulting (Virtual), ICIPE, NHIF, Prof. Anselimo Makokha, Amref International University, Dr Josea Rono, E&K Consulting, Yeddah Machage NHIF, ICIPE WHO Kenya, BRITAM) PLENARY DISCUSSION (10 minutes) Entertainment: KIPPRA Choir
10.30-11.00	INTERLUDE AND REFRESHMENT BREAK
SPECIAL SESSION 1 – OFFICIAL OPENING OF THE CONFERENCE Chair: Economic Planning Secretary, State Department for Planning Rapporteurs: KIPPRA	
11.00-12.00	**SS1_1 Recap of Conference Agenda & Welcoming Remarks** Rose Ngugi, Executive Director KIPPRA
	SS1_2 Opening Remarks: Dr Linda Musumba KIPPRA Board
	SS1_3 The Importance of Education Systems in Development of Human Capital ST&I Prof. George Magoha, MBS, EBS, CBS CS, Ministry of Education
	SS1_4 Role of ST&I in Enhancing Food Security and Nutrition in Kenya Hon. Peter Munya EGH CS, Ministry of Agriculture, Livestock, Fisheries & Cooperatives
	SS1_5 Keynote Address and Official Opening Mr Eric Simiyu Wafukho CAS, National Treasury and Planning
THEME 4: INFRASTRUCTURE	
PLENARY SESSION 4.1: ST&I Infrastructure Chair: Brian George Otieno, KTN Rapporteurs:KIPPRA	

12.00	**Deploying IoT Beyond Cities through Innovative Broadband Networks – The Opportunity of TV White Spaces** Presentation (5minutes) Leonard Mabele, iLab Africa Virtual **Infrastructure Development Pertaining PWDs** Presentation (5 minutes) Ms Gloria Njoki, Deaf Hope (PWD-Hearing) **Cyber Security Threats and Capacity Building to Address potential challenge in the implementation of the Big Four Agenda** Presentation (5 minutes) Richard Otolo, ilab Africa Virtual **PANELISTS (20 Minutes)** (Dr Sabyasachi, Dr Amit Kumar, Dr Kapil Patil-RIS, CA, NuPEA, ICT Association of Kenya, CISAK, Mr Herbert Alan (PWD-Albinism), Konza Technopolis, Paul Mugambi-PWD) PLENARY DISCUSSION (10 minutes) BOMAS OF KENYA Entertainment
13.00	LUNCH BREAK
14.00-16.40	ANNEX 2: BREAK AWAY GROUP DISCUSSIONS PROGRAMME
THEME 5: CROSS CUTTING ISSUES	
PLENARY SESSION 5.1 GENDER, PWDs, YOUTH Chair: Luke Muleka, Signs TV	Rapporteurs: KIPPRA
14.00-15.20	**Mainstreaming a Gender Perspective in Science, Technology, and Innovation** Ms Umulkheir Harun, Kesho Alliance Foundation Presentation (6 minutes) **Gender and ST&I** Presentation (6 minutes) Jayne Ndenga (PWD, Physical) A Short Clip on the Subject (4 Minutes) **Opportunities for the youth in ST&I** Presentation (6 minutes) Juliet Owino, YSK

	Technologies for Persons living with Disabilities Presentation (H8 minutes) Mr Peter Kabethi (PWD-Hearing) Virtual A Short Clip on the Subject (Innovation Activities of PWDs) (4 Minutes) **PANELISTS – (30)** (NCPWD, UN-Women, BLAZE, DIESK-Disabled Empowerment Society of Kenya, Hannah Wang'ombe, CEO AWIEK-Association of Women in Energy and Extractives in Kenya, NHIF, Paul Mugambi (PWD-Sight), UDPK United Disabled Persons of Kenya, Plan international) PLENARY SESSION - (10minutes)
PLENARY SESSION 5.2 ST&I DATA AND STATISTICS Chair: Mr. Nzomo Mbithuka	Rapporteurs: KIPPRA
15.20-16.20	**Availability and use of ST&I Statistics** Presentation (6 minutes) KNBS **Role of data protection in ST&I Sector** Presentation (6 minutes Ms Immaculate Kassait, Data commissioner A Short Clip on the Subject (4 Minutes) **PANELISTS – (30)** (Ms Nora Ndege, African Centre for Technology Studies Strathmore University, NACOSTI, NSE, NCPD) PLENARY SESSION - (10 minutes)
	Refreshment Break
16.40-17.30	PRESENTATIONS FROM THE BAGS

TIME	DAY 3: 25TH JUNE 2021
7.00- 8.00	KIPPRA DOCUMENTARY
8.00-8.15	ARRIVAL & REGISTRATION (ENTERTAINMENT-KIPPRA CHOIR)
8.15-8.30	PRAYERS- CHRISTIAN & ISLAM RECAP OF DAY TWO: Key highlights FACILITATOR: Kenneth Malot, KIPPRA MC: Noah Kipkemboi

THEME 6: BUILDING RESILIENCE THROUGH ST&I	
PLENARY SESSION 6.1- BUILDING RESILIENCE Chair: Dr. Duncan Ochieng, National Disaster Management Unit	Rapporteurs: KIPPRA
8.30-9.30	**Status of Disaster Preparedness in Kenya** Presentation (5 minutes) Paul Kimeu, National Drought Management Authority **Disaster Preparedness and the Role of ST&I** Presentation (5 minutes) Red Cross **Research and Impact on COVID 19 Pandemic** Presentation (5 minutes) Mr Boniface Wanyama, NACOSTI **Building resilience with ST&I** Presentation (5 minutes) Gladys Kitony, KRA A Short Clip on the Subject (2) **PANELISTS: (30)** (UN coordination of Humanitarian Affairs, NDOC, St Johns Ambulance, County Fire Fighter-Nairobi County) PLENARY DISCUSSION (10 minutes)
PLENARY SESSION 6.2- AGRICULTURE Chair: Prof. Agnes Mwang'ombe EBS, CAVS-UoN	Rapporteurs: KIPPRA
9.30-10.30	**Role of ST&I in Agriculture Sector Growth and Transformation** Keynote Speech (6 minutes) Prof Hamadi Iddi Boga PS, State Department for Crops Development and Agricultural Research **Agricultural Technologies and Food Security** Presentation (6 minutes) Dr Christian Tiambo, ILRI **Technologies on Scaling up Nutrition** Presentation (6 Minutes) Edgar Onyango, Scaling Up Nutrition Civil Society Alliance **Blue Economy and Technology** Presentation (6 minutes) Dr Jonathan Muguti, KMFRI

	A Short Clip on the Subject (2 Minutes) **PANELISTS: (30 Minutes)** (KEPHIS, Hydroponic Africa ltd, Ujuzi Kilimo, AFA, Mr. Kimote-National Cereal & Produce Board, KENAFF, Isaac Kalua-Founder Green Africa Foundation, Prof. Dominic Mwenja Miramar International) PLENARY DISCUSSION (10 minutes)
10.30-11.00	INTERLUDE AND REFRESHMENT BREAK (Kabarak Choir)
PLENARY SESSION 6.3- HOUSING Chair: Hon. Patrick Bucha	Rapporteurs: KIPPRA
11.00 -12.00	**The Role of ST&I in Affordable Housing in Kenya** Presentation (15 Minutes) Hon. James Macharia, EGH CS, Ministry of Transport, Infrastructure, Housing, Urban Development & Public Works **Waste management in relation to ST&I** Presentation (8 minutes) Sarah Njau, WEEE Centre A Short Clip on the Subject (2 Minutes) P**ANELISTS: (30 Minutes)** (Meru University, 14 Trees Kenya Ltd, NEMA, Kenya Property Development Association) PLENARY DISCUSSION (10 minutes)
PLENARY SESSION 6.4-INDUSTRIALISATION AND ST&I Chair: Dr. Moses Njenga, KIPPRA	Rapporteurs: KIPPRA
12.00 - 13.00	**Are we ready for 4th Industrial Revolution?** Presentation (6 minutes) Philip Thigo, Thunder Bird Africa **Artificial Intelligence** Presentation (6 minutes) Lilian Nganda Head of Communication, Microsoft Kenya

	SMEs and ST&I Presentation (6 minutes) Eng. Edward Karani Njeru, MSEA **The launch of KIBO satellite** Presentation (6 minutes) UoN A Short Clip on the Subject (2) **PANELISTS: (30)** (Kenneth Guantai CEO-Auto-Truck EA Ltd, , Dr. Simon Gichuku KAM, DMr. Charles Mwangi, Kenya Space Agency, Numerical Machine Complex, JKUAT, Lorna Mutegi iLab Africa, Ms Cindy Adem (PWD- physical)) PLENARY DISCUSSION (10 minutes)
13.00	LUNCH BREAK
14.00	**SPECIAL SESSION 2 – WRAP UP AND WAY FORWARD** Chair: Mr Koitamet Olekina, Board Member KIPPRA Rapporteurs: KIPPRA
14.00- 16.00	**SS2_1 Discussions and Conference Resolutions - Presentation of Conference Communique** Conference Chair: Janet Arum, KIPPRA
	SS2_2 Vote of Thanks Director General: Prof. Walter O. Oyawa
	SS2_3 Remarks Board Member KIPPRA: Dr Phoebe Ayugi Josiah
	SS2_4 Closing Remarks Chair of Board: KIPPRA
	SS2_5 Official Closing CAS: National Treasury and Planning
16.00	REFRESHMENT BREAK
	VISITORS LEAVE AT THEIR OWN PLEASURE

ANNEX 2: BREAK-AWAY GROUP DISCUSSIONS PROGRAMME

TIME	DAY 1:23RD JUNE 2021	
	BREAK AWAY GROUPS	
2.00-16.30	ARRIVAL AND REGISTRATION	
8.15-8.30	**BAG 1.1 (Group 1A) – Policy, Institutional and Legislative Framework** Chair: Dr Leonard Mabele Rapporteurs: KIPPRA Oral Presentation Presenter 1: Dr Daniel Mutegi Giti Applicability of Public Private Partnerships for enhanced development of Science, Technology, and Innovation in Kenya	**BAG 1.2 (Group 1B) – Development of Human Capital** Chair: Ms Nancy Laibuni Rapporteurs: KIPPRA Oral Presentation Presenter 1: Dr Stephen Macharia and Dr David Gichuhi Topic: Inclusivity of TVET Education for Mass Career Growth and Development in Kenya Presenter 2: Dr. Francis Gitagia Levering on technology universities and TVETS students for innovations in green investments for sustainability.
	BAG 1.3 (Group 1C) – Building Robust Innovation Systems Chair: Mr Amos Onchiri Rapporteurs: KIPPRA Oral Presentation Presenter 1: Michael Ogolla Intellectual Property Rights Laws and Innovation: Evidence from Kenya	

TIME	DAY 2:24TH JUNE 2021
2.00 -16.30	**BAG 1.2 (Group 1B) – Building resilience with ST&I** Chair: Adero Juma Adero Rapporteurs: KIPPRA Oral Presentation Presenter 1: Charles Oyaya Delivering Adequate and Affordable Housing using Novel Sanitation Technologies: A Review of the Policy, Legal and Regulatory Framework in Kenya Presenter 2: Bucha Patrick Mwenda Legal Framework on mitigating building failures: a critical ingredient for safe and secure affordable housing in Kenya Presenter 3: Beatrice Kinyua Leveraging on Digitalization to boost Export Based Manufacturing in Kenya Presenter 4: George Riheni Science, technology and innovation, public policy and resilience in development, kenya. Presenter 5: Dr Duncan Ochieng', Austine Aluoch, Ali Gakweli, Amos Ayieni Chemical, Biological, Radiological and Nuclear Risk Management in Kenya: Efforts, Successes, Challenges and Opportunities Presenter 6: Kombo Salim Understanding the link between resilience and economic systems Presenter 7: Prof. Lokuruk Michael Resilience Building for Food and Nutrition Security in Kenya's Arid and Semi-arid Lands-a Potential Strategy for the Big Four Agenda Presenter 8: Patrick Ogutu, Nicholas Oyie, Witson Ojenge A chicken chick's banda using neuro fuzzy logic technique for ensuring sufficient food supply Presenter 9: Dymphina Andima, Teresa Mwangi, Aloys Ondicho, Maurice Ondicho, Nelson Kidula Identification and creation of community-based organizations to implement integrated land water resources: Case study of Tende- Kibuon catchment, Southwest Kenya

ANNEX 3: YOUTH SIDE EVENT PROGRAMME

TIME	DAY 1: 23RD JUNE 2021
PLENARY SESSION (SE_1) – Science, Technology, and Innovation (ST&I) in Academia Chair: Jerome Ochieng, CBS PS, State Department for ICT & Innovation Rapporteurs: KIPPRA Youth MC: Ms Suzanne Silantoi	
10.00-11.00	**SE1_1 Youth Empowerment through ICT** Presentation (15 minutes) Dr Mathew Egesa, Technical University of Mombasa. **Commercializing Innovations to Enhance Opportunities for Youth in ST&I (Entrepreneurships, Patenting, Job Creation)** Presentation (9minutes) Ms Lizzy Mwamburi , University of Eldoret **Promoting the Agency and Participation or Engagement of Youth in Matters of ST&I** Presentation (9 minutes) Ms Zipporah Konga, KYEOP Plenary Session Video Interlude (3)
PLENARY SESSION (SE_1) Chair: Ms. Suzanne Silantoi	
11.00-12.00	SE1-2 Video Interlude (2 Minutes) **Promoting innovation and entrepreneurship among the youth in Africa** Presentation (9 minutes) Mr Jean Paul Adam, UNECA **Investing in the Youth Through ST&I Initiative** Presentation (9 Minutes) Mr Morris Ondiek, Youth Fund Video Interlude (2)

PLENARY SESSION (SE_1) Chair: ICTA	
12.00-13.00	**SE1-3 Talks Soft skills: Personal Branding and Emotional Intelligence** Presentation (9 minutes) Mr Domonic Mwangi, Tangaza University College. Plenary Session Video Interlude (3)
13:00	LUNCH and Entertainment
PLENARY SESSION (SE_2) – Campus Lifestyle, Challenges and Coping Mechanisms Chair: Riara University apporteurs: KIPPRA	R
14:00	**SE2_1 Students' Mental Health and Technology** Presentation (6 minutes) Mr Cleopah Kinywa Njiru - Chiromo Hospital Video Interlude (4) **Drug and Substance Abuse among Students** Presentation (6 minutes) Mr Adrian Kamau, NACADA **Gender Based Violence in Campus** Presentation (6 minutes) Ms Christine Okena, UN Women Video Interlude (5)
15:10	REFRESHMENT BREAK AND ENTERTAINMENT
PLENARY SESSION (SE_) – Youth Empowerment and Engagement Chair: Sabina Obere Rapporteurs: KIPPRA	
15.30-16.00	**SE_3.1 Career Networking and Challenges Faced in Transitioning into the Workplace** Presentation (6 minutes) Dorcas Wanaina, Consultant on Human Resource Management Video Interlude (6)
ABSTRACTS PRESENTATIONS	

16.00-17.00	**Social Media Activation** Presentations: Samantha Luseno 1. Facebook and Twitter Presentation (10 minutes) 2. LinkedIn and Instagram Presentation (10 minutes) YouTube 3. Presentation (10)
Entertainment: Music MC/Moderator:	
BACKGOUND MUSIC	